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POWER GENERATION
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JULY, 1936

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POWER

A McGraw-Hill Publication—Established 1884
PHILIP W. SWAIN, *Editor*

ENGINEERS

AMIDST the the interminable political discussions of recent years, *Power* has devoted itself almost exclusively to bread-and-butter information about engines and boilers, heating, refrigeration, diesels and so on. Only rarely does any political problem impinge so directly on the actual jobs of our readers that comment in these pages seems justified.

But such a situation is now at hand. We refer specifically to the problem created by the passage of laws, in a majority of the states, to license engineers for professional practice.

These laws are fully justified insofar as they define and protect the field of activity of the consulting engineer. They are a grave threat to the public welfare to the extent that they encroach on the established and reasonable rights of non-professional engineers. Just how far they do so encroach is still a matter for argument because of vaguely worded clauses in the laws themselves.

Let's be specific. Do these laws, as commonly worded, really mean that nobody but a licensed professional engineer may be employed to supervise the operation of the power services in a factory, institution or utility plant? We do not know, but if the courts should so construe them, and if the courts' decisions should be fully enforced, an outraged public opinion would undoubtedly amend the laws in short order. It has by no means been proved that the kind of experience and training required for a professional license would make for *safer* operation than the kind required today for an operating chief's license.

When it comes to professional services in the accepted sense, such as those rendered to clients by consulting engineers, there is little room for argument. This field, and the title "professional engineer," will become the exclusive property of professional licensees.

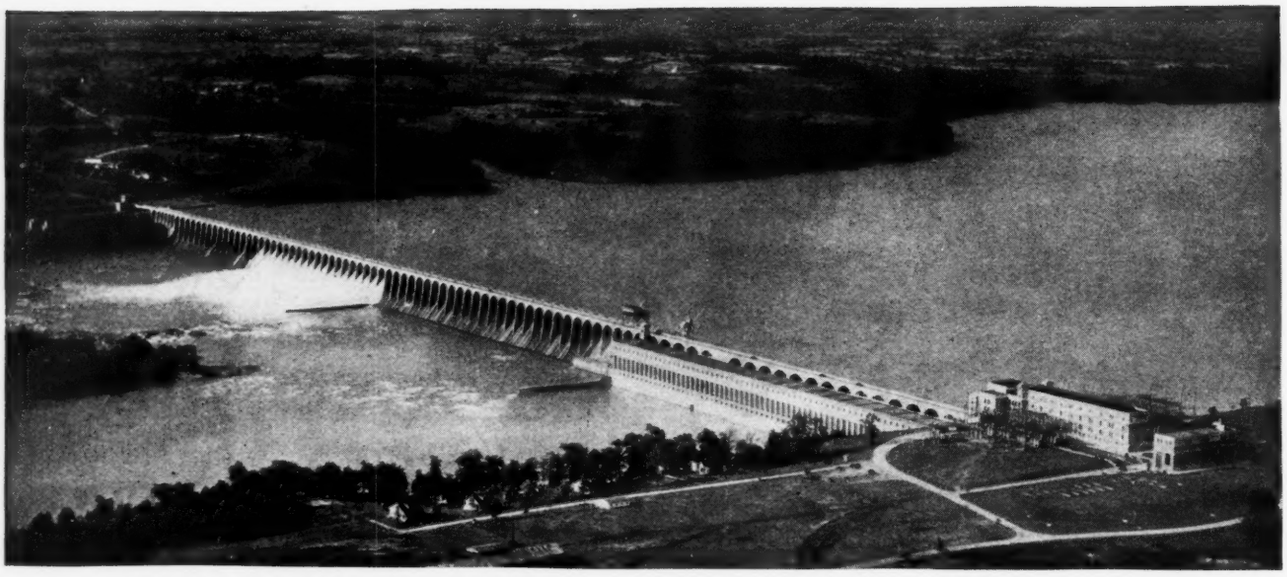
On the other hand, if John Smith, with a chief's license legally certifying that he *is* an "engineer," and with a record of decades of safe and competent operation, must forthwith become an underling, or at least give up a title sanctioned by long and undisputed usage, things will start happening—and fast.

It will not help matters to advise Smith that he can obtain a professional license himself if he can prove that he possesses certain qualifications, which he knows, and every engineer knows, bear little relation to the *safe* supervision of plant operation.

The group promoting professional licensing heard but little from the operating group in the early days and are undoubtedly somewhat surprised and perplexed at today's growing volume of protest. They reveal a sincere and commendable desire to compromise, but no compromise, in our opinion, can stay put unless it faces the "facts of life."

We do not believe that operating chief engineers as a class will quietly hand over their jobs to others for lack of a professional license that bears no provable relation to ability to operate safely. We doubt that they will give up the simple title of "engineer," and accept a belittling adjective. We are sure that they will welcome a growing body of professionally-trained engineers, specially tested in theoretical, as well as practical foundations, and fully protected by an exclusive title—which must not be the single word "engineer."

According to one of America's most democratic and cherished traditions, the simple title "engineer" is the property of no intellectual or official caste. It merely marks competency, however won, to handle men and machines safely and for useful ends. "Thou shalt not covet" thy neighbor's job, nor his title, nor anything that is thy neighbor's.



Wilson dam and power house at Muscle Shoals on Tennessee River provides for 610,000 hp., of which 260,000 hp. is installed

TVA HARNESSES THE TENNESSEE RIVER

CREATED originally to maintain and operate Muscle-Shoals power and nitrate plants, improve navigation and control destructive floods on the Tennessee River, the Tennessee Valley Authority program now includes eleven dams that will provide 9-ft. navigation on 650 mi. of the river, about 7,000,000 acre-ft. of water storage for river regulation and flood control, 2,650,000 hp. (possible) of generating capacity, and possible primary-power generation increased from 350 million kilowatt-hours at Wilson dam alone to 5.5 billion kilowatt-hours from all dams operating in a unified system.

Early in his administration, President Franklin D. Roosevelt selected the Tennessee River basin for intensive coordinated regional development of its natural resources as a means of relieving unemployment and for economic and social betterment of the people living in that territory. This project has been the center of so much controversy that many readers are no doubt wondering why this area was selected for such a development, how and by whom the work is being done, what has been accomplished, and what are the future plans. Work has now progressed to a point at which a fairly definite answer can be given to some of these questions.

Many factors influenced the selection of the Tennessee Valley for a coordinated development. Its drainage area lies in seven states: Virginia, North Carolina, Georgia, Alabama, Mississippi, Tennessee, and Kentucky. Within this valley of nearly 41,000 sq.mi. live more than 2,500,000 people. It contains a wide diversity of soil, minerals and climate, but relatively few large industries.

At Muscle Shoals, near Florence, Ala., the Federal Government already had a large investment in a hydro-electric plant, a steam plant, and a large nitrate plant, built as a war emergency measure, but left practically idle after its completion.

Proper regulation of the Tennessee River was necessary to prevent destructive floods and to improve navigation, the government having already made a large investment for that purpose, along its 650-mi. length from Knoxville, Tenn., to Paducah, Ky. At Muscle Shoals the river flow has been as low as 4,300 sec.-ft., the equivalent of 37,500 hp., therefore without river regulation this hydro-electric plant could never be a large producer of dependable power.

In 1930 the Corps of Engineers, U. S. Army, completed a comprehensive study of the river that had taken several years, and made a report to Congress. This report made recommendations as to possible dam and reservoir sites, reservoir capacities, river-flow regulation, navigation, flood control, power generation and other important details, thus forming an intelligent basis on which development of the river could be started.

In the Tennessee Valley, heavy rainfall, character of the soil, and scarcity of forest growth, combined to cause rapid surface runoff and to keep widespread erosion active on all bare and cultivated slopes. As a result the river is usually brown in color, because it carries away millions of tons of soil, washed off cultivated land and other areas denuded of forest cover. When reservoirs are constructed, silt from the water will be deposited and gradually fill them up. Consequently, control and prevention of land erosion and rapid run-off is the basic place to start a unified program of river regulation. While control of erosion must be part of any program for preventing silting, the more immediately important reason for this work is to conserve soil fertility and help

the farmer achieve a better economic position. The use of more cover crops and the resultant retention of greater amounts of ground water is essential to this agricultural work.

It was to carry out such a program as a means of relieving unemployment and improving economic and social well-being of the people that development of the Tennessee Valley was undertaken. Authority to do this was provided in a bill passed by Congress and signed by the President, May 18, 1933. This Act created the Tennessee Valley Authority, now generally known as TVA, directed by a board of three members, to carry out its purposes which are to obtain:

1. Maximum development of the Tennessee River for navigation.
2. Maximum flood control.
3. Maximum generation of electric power consistent with flood control and navigation.
4. Proper use of marginal land.
5. Proper method of reforestation of all land in the basin suitable for that purpose.
6. Improvement of economic and social well-being of the people living in the river basin.

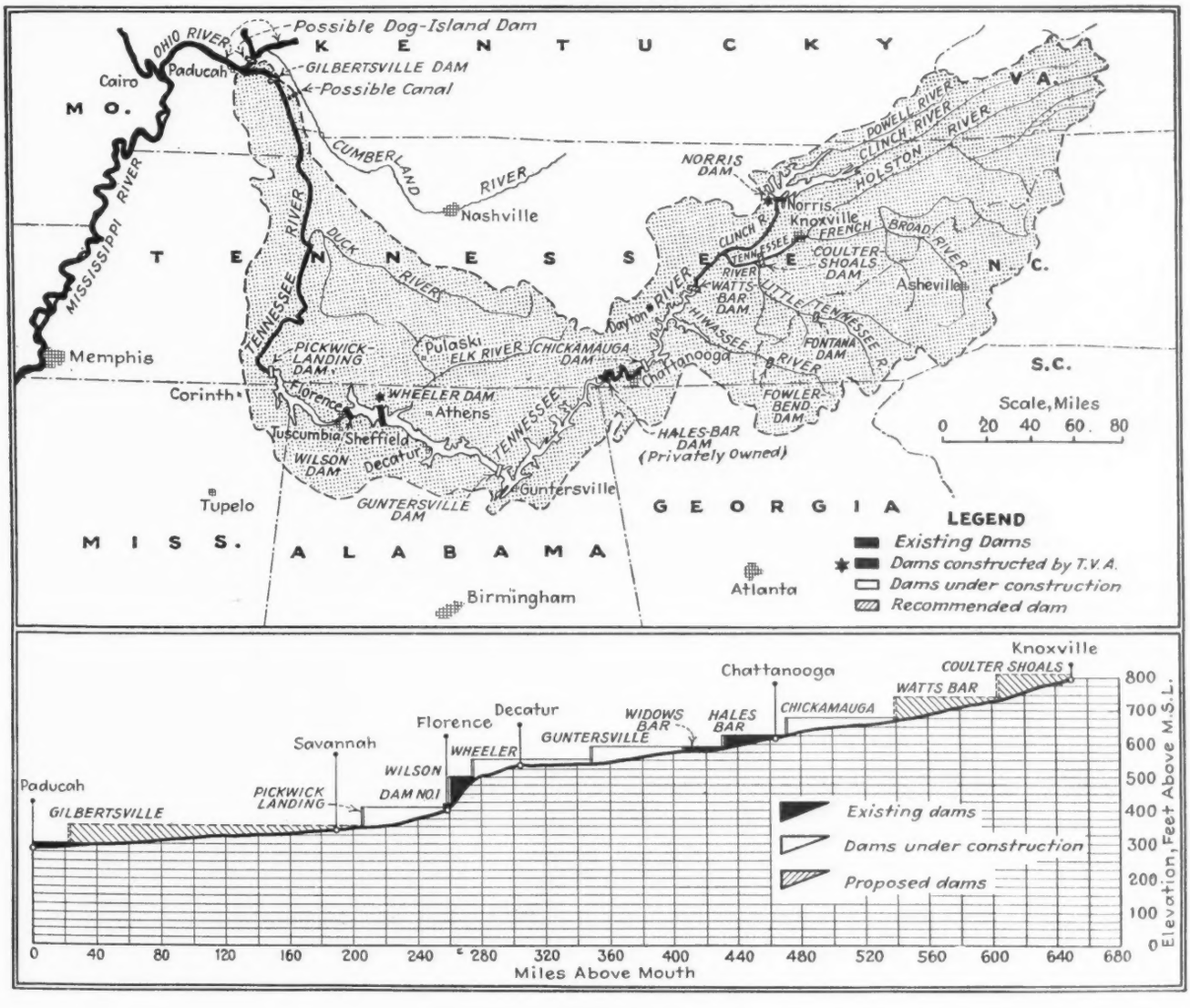
For chairman of the Board of Directors of the Tennessee Valley Authority, the President appointed Arthur E. Morgan, vice-president of the Dayton-Morgan Engineering Co., and former president of Antioch College. The two other directors named by the President are Dr. H. A. Morgan, former president of the University of Tennessee, and David E. Lilienthal, Public Service Commission of Wisconsin.

The Act turned over to the Authority all property at Muscle Shoals, except the locks, empowered the Authority to produce fertilizer, or to contract with commercial producers for production of fertilizer at Muscle Shoals, conduct experiments to reduce fertilizer cost, and provide farm organizations with fertilizer for large-scale experimental purposes.

The Authority was also authorized to sell and distribute surplus power generated at Muscle Shoals and other dams, not required in its operations and future operation of locks and other works to states, counties, and municipalities, corporations, partnerships and individuals within transmission distance of the dams. Construction of Cove-Creek dam and power house (now Norris) was also authorized. Since then construction of Wheeler dam was authorized by presidential order and building of other dams has been authorized by Congress in appropriation bills providing funds.

Since the creation of the Tennessee Valley Authority in 1933, the Act has been amended to clarify details and objectives in the light of experience of the first two

Fig. 1—Map showing location of dams that have been built, are under construction or proposed by TVA for early construction on the Tennessee River and its tributaries. The Dog Island dam and the canal have not been proposed or recommended by TVA. Fig. 2—Profile of the Tennessee River showing existing, under construction and proposed dams



years. The Authority has been instructed to construct dams and reservoirs in the Tennessee River and its tributaries to provide a 9-ft. navigation channel from Knoxville, Tenn., to Paducah, Ky., in keeping with the depth of connecting inland waters. Under present conditions, during low water a navigation depth of only 1 ft. is obtained in certain parts of the river. As amended in 1935, the Act required the directors of the Authority to report to Congress their recommendations not later than April 1, 1936, for a unified development of the Tennessee-River system. This report has been made, and much of the following information is taken from it.

Fig. 1 shows the Tennessee-Valley drainage area and the dams that have been built, are under construction, and are proposed in the latest report of the Authority to Congress. To this map has been added a line indicating the approximate course of the Cumberland River, location of the possible Dog Island dam on the Ohio River, and canal between the Cumberland and Tennessee Rivers. The suggested Dog-Island dam and canal between the Cumberland and Tennessee Rivers have not been proposed or recommended by TVA, but have been added in the illustration as they are related to development of the Tennessee River below Pickwick Landing.

At one time studies were made for a dam on the Ohio River below the mouth of the Tennessee of sufficient height to back water up the Tennessee River to Pickwick Landing, and give a navigable depth of 9 ft. This dam would also back water for a long way up the Ohio, Cumberland, and Wabash Rivers. Gilbertsville dam is the one that will likely be built. It allows full development of the Tennessee River, and does not conflict with the development of the Ohio and Cumberland Rivers. A dam on the Ohio at Dog Island and a canal between the Cumberland and Gilbertsville reservoir would create one large reservoir as would a dam below the mouth of the Ohio.

Construction of Gilbertsville dam has been recommended by TVA to Congress. This dam is 23 mi. above Paducah, Ky., and 184 mi. below Pickwick-Landing dam. It will provide a total of 1,380,000 acre-ft. of controlled flood storage at a cost of about $60,000,000 for the dam and storage reservoir, without power-generating facilities, but with provisions to install approximately 350,000 hp. under 46-ft. head. An additional 1,400,000 acre-ft. of flood storage can be obtained in this reservoir at a cost of about $14,000,000.

Fig. 2 is a profile of the Tennessee River showing existing, under construction, and proposed TVA dams and the Hales Bar dam of the Tennessee Electric Power Co. This shows that the headwater level of each dam is tailwater level of the one above on the river.

Table I gives important data on all TVA projects on the Tennessee River, and its tributaries, that have been constructed or are under construction or have been proposed, with the exception of Fontana dam. These include eleven dams, eight of which are on the Tennessee River, and serve the triple purpose of providing 9-ft. navigation, flood control, and power generation. Three dams on the tributaries provide flood-control and river-regulation storage for navigation purposes and power-generation capacity. Hales Bar dam and power plant with 44,000 hp. installed, on the Tennessee River, is owned by the Tennessee Electric Power Co. and is not included in the table. In the TVA report to Congress it is recommended that this dam be improved and its height increased.

If all the proposed TVA projects are built they will provide storage of about 7,000,000 acre-ft., and total capacity of 2,650,000 hp. can be installed. With Norris and Fowler-Bend storage reservoirs in service, the average minimum flow of the Tennesssee River will be increased 350%, reaching as high as 477% at Gilbertsville dam, as shown in Table II. Possible primary-power generation will be increased from 350-million kilowatt-hours at Wilson dam alone to 5.5 billion kilowatt-hours for the entire system. When all the dams are built they will represent a total investment of $360,000,000 exclusive of power-equipment costs, except at dams where it is now installed or being installed.

Wilson dam and power house, the formerly much talked about Muscle-Shoals project, was taken over by TVA in 1933 and since then operated by it. The power house is completed with provisions for installing 610,000 hp. in 18 units under a 92-ft. head. Four 30,000-hp. and four 35,000-hp. units are now installed. Near Wilson dam is a 60,000-kw. steam plant maintained by TVA. The Tennessee Valley Authority Act gives the Authority the right to complete the steam plant and add capacity at Wilson dam. This work has not been done

[1]Table I—Data on Dams Operated, Being Built, or Proposed by TVA on the Tennessee-River System

	Gilberts-ville	Pickwick-Landing	Wilson	Wheeler	Gunters-ville	Chicka-mauga	Watts-Bar	Coulter-Shoals	Norris	Fowler-Bend
Designed by.....	TVA	TVA	Hugh L. Cooper	Reclamation Bureau	TVA	TVA	TVA	TVA	Reclamation Bureau	TVA
Constructed by..	a	TVA	Corps of Engineers	TVA	TVA	TVA	a	a	TVA	a
Const. started...	a	Mar., 1935	April, 1918	Nov., 1933	Dec., 1935	Dec., 1935	a	a	Oct., 1933	a
Const. started, proposed.....	1939	.....	.....	.....	.....	.....	1939	1940	.....	1937
Completed.....	.....	.....	Sept., 1935	1936	.....	.....	.....	.....	1936	.....
Comple. proposed	1944	1939	.....	.....	1940	1940	1942	1943	.....	1940
Cost, dollars.....	60,000,000	26,700,000	46,950,748	33,800,000	29,400,000	31,600,000	31,000,000	20,000,000	36,600,000	15,000,000
Length, ft.....	8,300	7,715	4,860	6,335	3,980	5,685	2,900	2,100	1,872	1,265
Height, ft.....	55	107	137	72	80	104	.....	.....	265	300
Concrete, cu.yd..	.....	608,000	1,400,000	682,000	326,000	425,000	.....	.....	1,150,000	.....
Earth fill, cu.yd..	.....	2,984,000	.....	.....	550,000	1,000,000	.....	.....	.....	.....
Reservoir, acre-ft. (total capacity)	3,200,000	1,032,000	500,000	1,260,000	951,000	667,000	.....	.....	2,570,000	480,000
Reservoir area, acres.....	168,000	41,600	14,500	66,600	63,300	32,500	.....	.....	34,200	6,300
Backs water, mi..	184	53	15.5	74	82	59	74	53	b	22
Locks, size, ft....	600x110	600x110	300x60	360x60	360x60	360x60	360x60	360x60	None	None
Lock lifts, ft.....	60	67	89	50	45	52	63	75	None	None
Average head, ft.	45.5	54	92	50	38	44	61.5	65.5	129-194	.....
Hp. (initial).....	None	None	261,400	90,000	None	None	None	None	132,000	.....
Hp. (possible)...	350,000	276,000	610,000	360,000	130,000	200,000	200,000	75,000	132,000	110,000

[1]Data on Gilbertsville, Watts-Bar, Coulter-Shoals, and Fowler-Bend dams, as well as plants now under construction are subject to change as studies progress. Congress has not approved the proposal to build Fontana dam, which was to be 450 ft. high and 1,750 ft. long.

a Recommended by TVA for construction.

b Backs water 72 mi. up Clinch River and 63 mi. up Powell River.

as it has been found that, for the present, TVA power needs can be more economically provided by power units installed in other plants now under construction.

Wheeler dam and power house, next above Wilson dam, are well on toward completion and will go into service some time this year (see pages 386 and 7). An article in the September number will describe this project.

Work has also been started on the Guntersville and Chickamauga dams, and these combined with Hales-Bar dam, which it is proposed to improve, will back the water up to the site of Watts-Bar dam. At present no power is to be installed at these dams, but provisions will be made for future installation shown in Table I. Three dams, Gilbertsville, Watts-Bar and Coulter-Shoals, remain to be built to provide 9-ft. navigation on the Tennessee River from its mouth to above Knoxville, a distance of 652 mi. Construction of these dams has been recommended by TVA to Congress. Fowler-Bend storage dam on the Hiawassee River has been authorized by Congress and construction is scheduled to start next year. Legislation authorizing the Gilbertsville and Watts-Bar dams is now in conference between the House and Senate.

Norris dam power plant on the Clinch River is about ready to operate. This project is a navigation, flood-control, water-storage and power development, and will in general operate only when there is insufficient flow in the main river. It has already served one of its purposes by materially reducing the peak of a serious flood at Chattanooga last spring. An article in August *Power* will describe this project.

Table III shows the dates when work was started or when it is proposed to start work on the different TVA projects, and when the projects are to be completed. It will be seen that 1943 is the proposed completion date for the entire project.

A power transmission line has been built by TVA from Wilson dam to Norris dam. The authority is operating the hydro plant at Wilson dam, supplying power to several communities that operate their own power systems, to TVA nitrate plant at Muscle Shoals, to its construction projects, and also sells power to some of the power companies. Most of the efforts to use TVA power on a large scale have been blocked by the courts. Legal phases of the feature of the development have not yet been definitely decided.

Table II—Possible Increase in Firm Power in TVA Plants on Tennessee River With Norris and Fowler-Bend Reservoirs in Operation

Project	Minimum Weekly Flow, Cu. ft. per Sec.		Continuous Power	Continuous Power	Per Cent Increase,
	Unregulated	Regulated	Unregulated Flow, Hp.	Regulated Flow, Hp.	Continuous Power
Coulter Shoals...	1,700	2,400	10,500	15,000	41
Watts Bar.....	2,900	11,800	17,000	70,000	307
Chickamauga....	3,500	16,000	14,000	65,000	357
Guntersville.....	4,100	16,300	15,000	60,000	298
Wheeler.....	4,150	18,600	20,000	90,000	348
Wilson.....	4,300	18,900	37,500	165,000	340
Pickwick Landing	4,350	20,100	21,500	100,000	362
Gilbertsville.....	4,400	25,400	19,000	110,000	477

Table III—Dates for Starting and Completing TVA Projects

Project	Work Started	Work to be Started	Work to be Completed
Wheeler Dam.....	1933	....	1936
Norris Dam.....	1933	....	1936
Pickwick Landing Dam.....	1935	....	1939
Guntersville Dam.....	1935	....	1940
Chickamauga Dam.....	1936	....	1940
Fowler Bend Dam.....	....	1937	1940
[1]Watts Bar Dam.....	....	1939	1942
[1]Gilbertsville Dam.....	....	1939	1943
[2]Coulter Shoals Dam.....	....	1940	1943

[1]Recommended for construction by TVA and legislation authorizing this work is now in conference between the House and Senate.

[2]Congress has not yet been requested to authorize construction of Coulter Shoals dam though this project is recommended for the unified development of the Tennessee river system and will in time be taken up.

EXHAUST LINES

By E. J. Tangerman

Out in Minneapolis, officials of the Minneapolis Gas Light Co. recently demonstrated an auto powered by natural gas stored in two tanks. The car acted just like a gasoline-powered unit, accelerating just as fast, running just as smoothly. Fuel cost averaged half a cent a mile, the car running eight to ten miles on 32 cu.ft. of gas compressed to 125 lb. John Swanson, vice-president of the company, feels that this fuel will be practical when gas can be compressed economically to 2,000 lb. (as in oxygen tanks), since this would carry a heavy 8-cyl. car about 70 miles.

In Vancouver, a truck has been powered with wood gas derived from charcoal. Dominion Forest Products Laboratory, Point Grey, B. C., has been running it for some time, checking the extensive European work with this type of engine. Some trucks burn the wood direct, others use charcoal to generate the gas. The engine must be started on gasoline and the hopper has to be filled twice a day. Even at that, they think in Vancouver that it is practical for commercial cars, although private-car drivers would consider the equipment unsightly. But in Germany, they've put the whole producer at the back of the car, in that beavertail that manufacturers have been trying to fill with spare tires and trunks.

A friend of ours recently was in a hurry to get diagonally northeast across town, and told his taxi driver so. The driver started north, then after a few blocks cut off on a street angling to the east. Our friend tapped on the glass and said, "Why didn't you keep going north for another ten blocks, then turn east?" The driver turned around and looked at him coldly. "Since when are the two sides of a triangle shorter than the hypotenuse?" he asked.

Said *The Boston Transcript*, May 18, "Now the boiler room beautiful. It may have its appropriate color scheme. The housewife has discovered that art in the kitchen need not be limited to culinary art. Why should not the firemen enjoy the soothing influence of harmonious decoration in the boiler room?

"The question was presented at the convention of the American Federation of Arts in Washington. Dean Melvin E. Haggerty of the School of Education of the University of Minnesota told the delegates of the appeal for assistance which came from the Minneapolis municipal power plant. Its managers wanted to know in what colors to paint the walls of the boiler room. Experts hurried there. They decided that the floor should be red; lower wall, green; upper wall, cream; boilers, silver-faced with stripes. And the convention was told that the firemen are appreciative and happy."

NEW BOILER AT MCDONALD MILLS

Automatic combustion control and a chain-grate stoker burning coke breeze or slack coal are only two of many features in the new boiler at the Youngstown, Ohio, plant of Carnegie Illinois Steel Co.

RECENT additions to the McDonald Mills of Carnegie Illinois Steel Co., Youngstown, O., demanded an increase in steam-generating capacity. This has been provided by installing a boiler in a new power plant located between existing mill buildings in the bar-mill group. The boiler is fired with a chain-grate stoker in a combination arch furnace designed for burning coke breeze or slack coal with forced draft.

The new bent tube, 4-drum boiler with 6,154 sq.ft. of steam-making surface, and single-pass baffling, has a design steaming capacity of about 40,000 lb. per hr. When burning coke breeze containing 10,750 B.t.u. per lb. in a furnace of 1,384 cu.ft. volume, the heat liberated is 45,500 B.t.u. per cu.ft. at design rating. Equipped with a two-loop continuous-tube superheater of 800 sq.ft. area, 150 deg. superheat is obtained at 40,000 lb. per hr. steaming rate. Although designed for 250-lb. pressure the boiler is operated at 150 lb., the pressure of the older steam plant. The steam is used for tar atomization in the billet-heating furnaces, in pickling operations, in general mill process use and for building heating.

A cross section of the boiler and furnace is shown in Fig. 3. The stoker is of the forced-draft type with side air admission into five compartments. Dampers control the air flow to each compartment to insure proper combustion over the whole stoker area. Water boxes in the furnace side walls along the line of the fuel bed prevent slagging at the fire-bed level. The rear ends of the water boxes connect to the lower drum and their front ends are piped into the bottom of the front steam drum. This provides a continuous circulation of water from lower drum through water boxes to steam drum.

Dual steam and electric drive is an interesting feature of the stoker. The drive unit comprises a steam turbine, an electric motor and a Reeves variable-speed transmission. The turbine and motor are mounted on the variable-speed transmission to form a compact unit. The turbine connects to one end of the Reeves driven shaft and the motor to the other end of the shaft by silent chains. A third chain connects the variable-speed output shaft to the input worm shaft of the double-reduction worm gear on the stoker. Normally the turbine will drive the stoker with the motor disconnected. When starting with steam plant down the motor will do the driving. With steam-turbine drive on the constant-speed forced-draft fan and variable-speed transmission on the stoker, all under control of an automatic-combustion-control system, a flexible combination obtains for a wide range of efficient boiler and furnace operation.

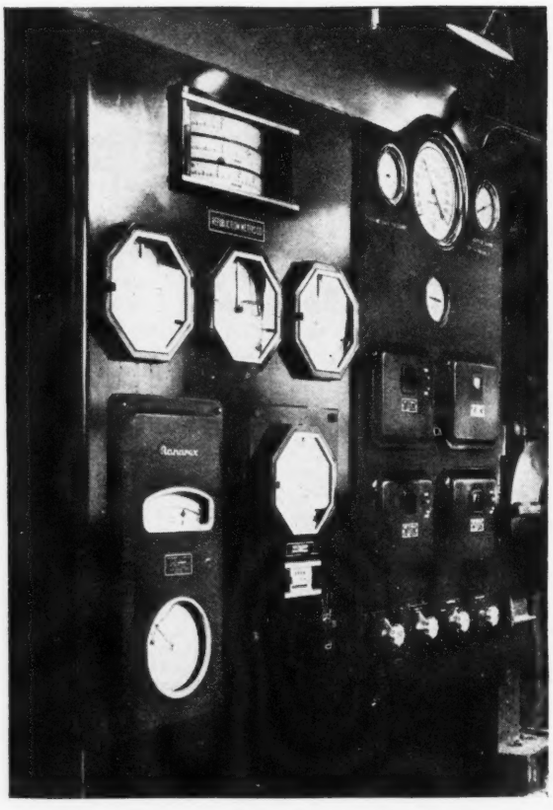
Boiler feed is supplied from existing reciprocating pumps and feedwater heater. Continuous blow-down from the upper middle drum flows to a flash tank discharging flashed steam to the exhaust steam line and blow-down to an external sump. Exhaust steam from stoker and fan turbines is returned to the feedwater heater.

Ashes are sluiced from the divided compartment at the stoker dump through gratings to an external pit from which point a high pressure-hydraulic ejector lifts the ash and discharges it to an outside sump at yard level.

With heavy steam demands placed on the boiler almost from the day of its being put in service, the automatic combustion control has had a real work-out in maintaining uniform furnace conditions and delivering steam at a constant pressure of 150 lb. This control system is of the electro-pneumatic type, employing a variable air-loading pressure for transmitting the master-control action to the various individual controllers, together with electric-motor drive units for the several regulated elements. The master controller is connected to the main steam header and responds to changes of header pressure with load so as to proportion a master air-loading pressure to steam-load requirements.

This controller consists essentially of a combined air-throttle and bleed valve actuated by a Bourdon tube subjected to steam pressure, Fig 4. The master air-loading pressure, as adjusted by the master controller, is applied to diaphragms on the air-flow and fuel-feed controllers

Fig. 1—Operation of new boiler is centered in this combination automatic combustion-control and meter panel



for the boiler, where it serves as a loading force representative of required boiler output.

An air-flow controller at the boiler functions to maintain a definite relation between air-loading pressure and differential pressure across an orifice in the forced-draft duct. Whenever the orifice-pressure differential fails to balance the master-loading action, contacts at the controller actuate a motor drive unit for the forced-draft damper to produce required draft change. Acting in conjunction with the air-flow control, a furnace-pressure controller at the boiler functions to maintain furnace draft at a predetermined constant value by actuating a motor drive unit for the uptake damper.

Metered fuel-feed control is applied through a controller which functions to balance a force dependent upon stoker speed against the master air-loading pressure. An electric tachometer connected to the stoker drive is employed in conjunction with solenoids on the fuel-feed controller to produce a force representative of stoker speed. The contacts of the fuel-feed controller act upon a pilot-motor drive for the variable-speed stoker transmission.

Each individual-draft and fuel-feed controller is equipped with two sets of contacts. One set effects a slow rate of control action in response to a small unbalance at the corresponding controller, and the other set of contacts produces rapid control action in response to a major unbalance at the controller. This type of variable response serves to provide control action in proportion to change in demand without hunting.

Three operating types of control are provided for the boiler: (1) Master automatic—in which fuel and air supplies are proportioned in the correct ratio to each other and supplied in response to steam demand. Furnace pressure is automatically maintained. (2) Base-load control—by which the fuel and air are proportioned

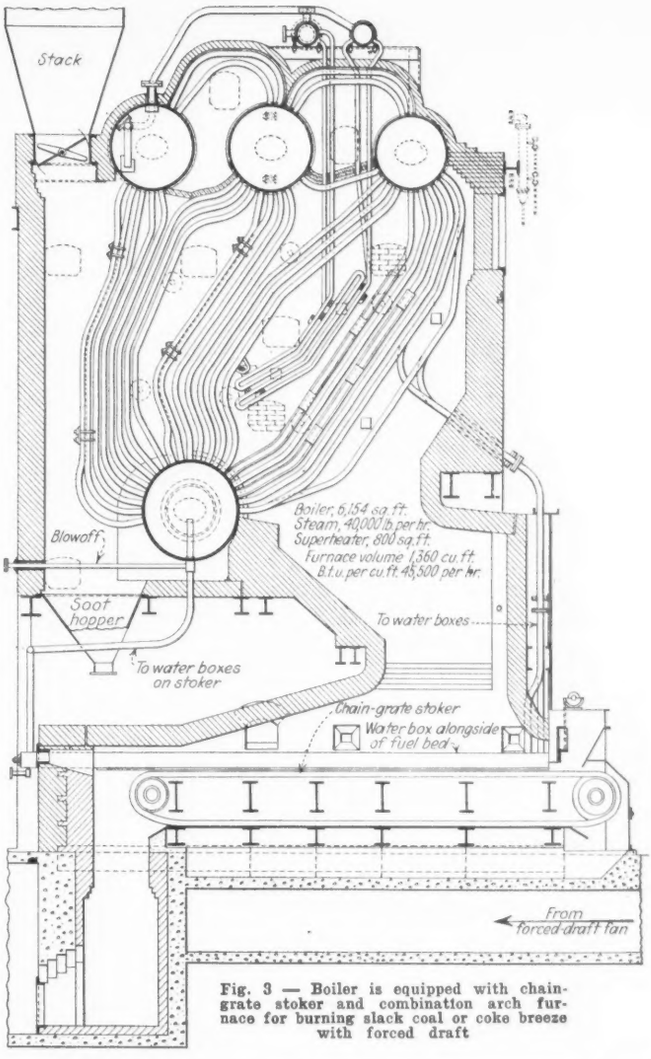
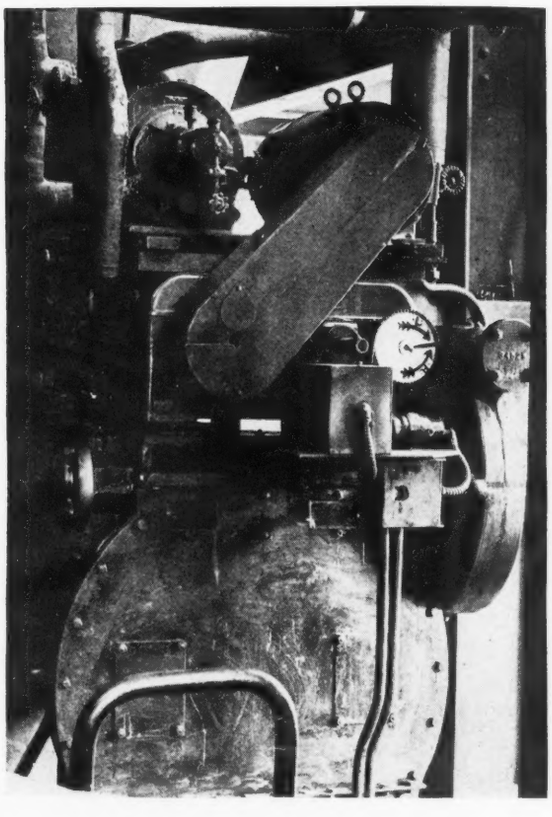


Fig. 3 — Boiler is equipped with chain-grate stoker and combination arch furnace for burning slack coal or coke breeze with forced draft

Fig. 2—Chain-grate stoker can be driven by either a steam turbine or motor through chain drives and a variable-speed transmission



PRINCIPAL EQUIPMENT IN NEW PLANT

Carnegie-Illinois Steel Co., Youngstown, O.

Boiler, Stirling type	Babcock & Wilcox Co.
Number 1; heating surface 6,154 sq.ft.; max. continuous cap., 40,000 lb. per hr.; design working pressure at boiler drum 250 lb.g. Present operating pressure, 150 lb. per sq.in.; design total steam temp. 560 deg. F. at 40,000 lb. per hr.	
Superheater, two-loop continuous tube, 800 sq.ft.	Babcock & Wilcox Co.
Furnace volume, 1,360 cu.ft.; max. B.t.u, liberated, 45,500 per cu.ft. per hr.	
Refractories	Niles Firebrick Co.
Boiler arches	M. H. Detrick Co.
Boiler walls	Niles No. 1 and Davis No. 2 brick
Boiler heat insulation	Johns-Manville
Stoker, chain grate, projected grate area 173 sq.ft.	Babcock & Wilcox Co.
Motor drive for stoker	Reliance Elec. & Eng. Co.
Turbine drive for stoker	Carling Turbine Blower Co.
Variable-speed transmission for stoker	Reeves Pulley Co.
Chain drives for stoker	Morse Chain Co.
Breechings, stack and coal bunker	American Bridge Co.
Combustion-control equipment	Leeds & Northrup Co.
Water Columns	Reliance Gauge Column Co.
Soot blowers	Diamond Power Specialty Corp.
Forced-draft fan	B. F. Sturtevant Co.
Turbine drive forced-draft	Moore Steam Turbine Corp.
Coal Distributor	Stock Engineering Co.
Coal-handling equipment	Jeffrey Mfg. Co.
Motor drives for coal handling	Master Electric Co.
Coal meter	Bailey Meter Co.
Ash-handling equipment (hydraulic)	Allan-Sherman-Hoff Co.
Blowoff valves	Babcock & Wilcox Co.
Safety valves	Crane Co.
Non-return valves	Golden-Anderson Valve Specialty Co.
Stop and check valves	Consolidated Ashcroft Hancock Co.
High- and low-pressure valves	Crane Co.
Piping contractor	Own staff of McDonald Mill
Pipe heat insulation	Johns-Manville
Boiler-meter panel board	Republic Flow Meters Co.
Steam-flow meter	Republic Flow Meters Co.
Pressure gages, indicating	Consolidated Ashcroft Hancock Co.
Pressure-gage, recorders	Republic Flow Meters Co.
Temp. recorders, draft gages	Republic Flow Meters Co.
Flue-gas temperature recorders	Republic Flow Meters Co.
CO_2 indicator and recorder	Permutit Co.

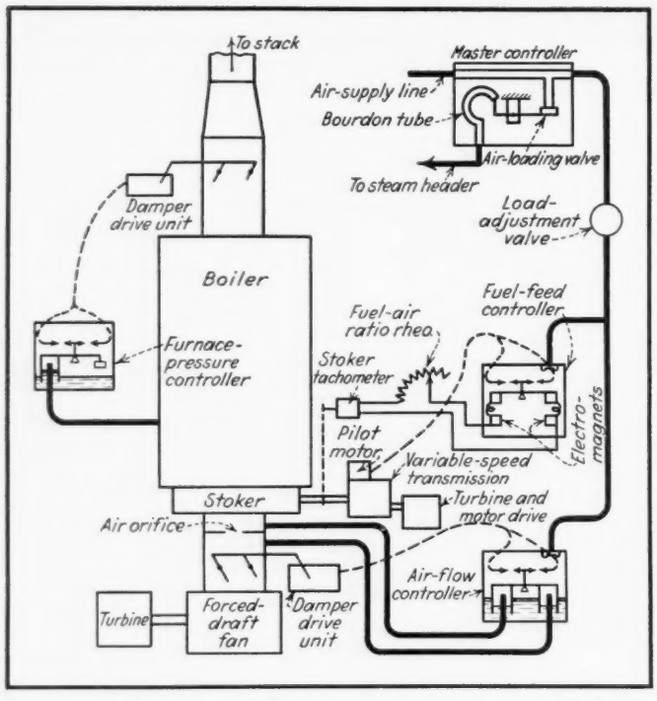


Fig. 4—Schematic diagram of electro-pneumatic type of automatic combustion control

in correct ratio to each other, but supplied in response to a manually adjusted air-loading pressure. Furnace pressure is maintained automatically. (3) Push-button control—by which remote centralized, but segregated control of dampers and stoker speed is made available by means of push-button stations located on the controller cases.

When necessary, changes in the fuel-air ratio can be made readily and promptly to meet a change in B.t.u. value, moisture content, etc., of the fuel, by simply turning a fuel-air ratio rheostat located at the control panel. A change in fuel-air ratio made at one rating is maintained over the full range of rating. At the present time a western Pennsylvania slack is being burned. However, when available, coke breeze will regularly be used.

Several protective features are incorporated in the control. For example, a failure of air-supply pressure does not shut the boiler down. In such an emergency a supply pressure interlock causes the motor drive units to remain stationary, and the boiler continues to operate at the rate at which it was running at the time of the air failure. By turning a selector switch, the boiler can be operated on push-button control until the air supply can be restored. Similarly, an interlock is provided when the limit of uptake draft is reached, to prevent further increase in forced draft or stoker speed.

All of the controllers and associated relays for the boiler are grouped upon a unit panel, Fig. 1. This construction reduces installation expense to a minimum and centralizes the apparatus so as to facilitate operation and inspection.

CONNORS CREEK CORRECTS DEPOSITS

SHORTLY after the first of the new 30,000-kw., 600-lb., 850-deg. units at Connors Creek plant of Detroit Edison Co. went into operation, it was noticed that first-stage pressure at full load was gradually increasing. Within a month this increase amounted to 10 lb. The terminal difference of the stage heaters was increasing, and final feedwater temperature decreased 20 deg. Likewise, the pH of the boiler water dropped, and upon investigation a slight amount of boiler corrosion was found.

Feedwater treatment to increase the pH value of the boiler water was immediately started, supplementing the coating of Apexior Number 1 applied when the boilers were erected. This treatment included the use of sodium sulphite to remove oxygen and apparently stopped further increase in first-stage turbine pressure. However, the unit could not be taken out of service for inspection until 6 months after the treatment was started. Then, as had been expected, deposits were found on all blades. On the 12th- and 13th-stage blades (the moisture zone) deposits were particularly heavy. They were found to be largely iron oxide, with some silica and organic material.

The turbine spindle was taken out and the deposits effectively removed from both blades and diaphragms with pulverized-coal ash from the company's Trenton Channel plant. The cleaning was done with hand lances with $\frac{3}{16}$-in. nozzle opening through which the ash was forced with air at 100 lb. pressure. The ash did not cut the turbine blading, but did restore a large part of the original blade polish. The nozzles of the hand lances, however, wore quite rapidly, and several were used up during the cleaning.

A considerable amount of deposit was also found on the tubes of the feedwater heaters. In the time available, it was possible to clean only the 8th- and 11th-stage heaters. In this operation, a Karey cleaning outfit was used with a hot solution of Oakite (25% by volume) and water. The solution was pumped at 100 lb. pressure through a $\frac{1}{16}$-in. nozzle 3 in. wide. This cleaning decreased the terminal difference of the two heaters from 13 to 7 deg. for the 8th-stage and from 17 to 10 deg. for the 11th-stage heater. Final feedwater temperature was raised 6 deg.

While the turbine was down, the hot well, which had been painted with Apexior Number 3 also was inspected. It was found that oil, which had not been removed from superheater tubes before starting the new boilers had worked down to the hot well and there reacted with the coating. Most of it had been removed, but some floated on the water and some adhered in sticky globs to the side of the hotwell. It is believed that some of this oil accumulation got into the boiler and was responsible for some damage to the Apexior Number 1.

Sides of the hotwell were first cleaned with steam and then scraped by hand.

When Belt is Overloaded— WHAT THEN?

IN SPITE of all the sound advice published on belt selection, it is not uncommon to find many drives giving trouble because they are overloaded. Several expedients are available for correcting overload conditions. Before discussing these, it may be well to reiterate something that should be done when selecting belts to make sure of sufficient capacity for the job.

A single-ply medium-weight, oak-tanned leather belt 5 in. wide, when running 2,500 ft. per min., has a power-transmitting capacity of about 5 hp. This does not by any means indicate that this belt is suited to connect a 5-hp. motor to its load. Pulley sizes and their center distance have a marked influence on how much power a belt will transmit without requiring excessive tension to prevent slipping.

Load Characteristics

Power required to start the load may be of greater importance than the normal rating of the motor in determining the size of belt required. Some loads require from 200 to 300% normal running torque to start. A load that may start with normal torque in the summer may require double that in winter. A conveyor that may start fairly easily under normal conditions may require a high torque if something happens and material piles up on it. One of the first things, therefore, to consider when selecting a belt is how much pull will be required under the worst conditions to start.

Running characteristics of the load also have an influence. A load may start easily but, while running, develop high peaks of short duration, or the load may be pulsating, as with a compressor. Where a flywheel is provided to absorb part of peak loads, such as occurs with punch presses and similar equipment, it will be well to consider if the motor has characteristics suitable for flywheel applications. If it has not, conditions may be very severe for the belt. On any type of load that develops sudden peaks, a motor with drooping speed characteristics will be more favorable to the belt than a constant-speed machine.

A wound-rotor motor will develop up to 300% starting torque. If there are possibilities that the load will require such a torque to start, then provisions must be made for this when selecting the belt. Many a.c. squirrel-cage motors are started by connecting them directly across the line. They start their loads quickly and develop about 200% full-load torque during part of the starting period. With high-slip, high-torque, squirrel-cage motors, starting torque may reach 2.5 times normal full-load torque.

How well these and other factors are weighed in the selection of a belt drive will determine the success or failure of the drive. A belt, however, is like any other type of drive in that it must be selected for the conditions under which it is to operate.

Frequently the lowest-cost remedy for an overloaded belt is to install a new belt and pulleys of sufficient capacity, and put the old equipment into stock. Sometimes, conditions prevent doing this; then other expedients must be tried. If the smaller pulley is steel, changing to a high-grade paper or wood type will give an increase in power up to 25%. Covering steel pulleys with belting will have a similar effect.

Where pulleys having high coefficients of friction are used, it may be possible to obtain a new belt having greater power-transmitting qualities than the one used. This is something to be determined by checking up with belting manufacturers. If the power source is a motor or a rigid base, changing to a pivot base will improve conditions considerably. Not only can more power be transmitted with a given belt, but its life will be increased.

Installing a gravity idler on the belt will give a greater increase in power than a pivoted base on the motor. The idler, however, puts a reverse bend in the belt that tends to reduce its life.

Up to a speed of about 4,500 ft. per min., power that can be transmitted by a belt increases approximately as the speed. When speed is below this value, installing larger pulleys will increase belt power. For example, increasing the speed of a belt from 3,500 to 4,500 ft. per min. will increase its capacity about 20%. To do this requires installing two new pulleys and splicing a piece into the belt.

Thicker Belt

In some cases the pulley diameters may permit a change to a thicker belt. For example, assume a medium single-ply leather belt operating on a 10-in. pulley. Normally a medium-weight double-leather or a 6-ply rubber belt can be operated on this size pulley. Such a change will give an increase in power of from 30 to 50%, depending upon belt speed and other factors. The slower the speed the greater will be the per cent increase in power-transmitting ability.

On some drives it is not possible to increase pulley sizes because of space limitations, or the driver-pulley diameter is fixed, as with the flywheel of a compressor. If some of the foregoing suggestions cannot be used to obtain more capacity, a wider belt may solve the problem. Care must be used in doing this, because increased bearing loading may cause serious heating. It is seldom safe to increase belt width more than 20% above that permitted by standard pulleys recommended by the motor manufacturers.

When short-center belt speeds are low and none of the foregoing suggestions can be applied to relieve overloads, the most economical solution to the problem may be a chain or some other form of drive. Chains are essentially slow-speed drives, but because of their great strength are capable of transmitting large power and yet occupy a comparatively small space.

Operating Experience With HYDROGEN COOLING

By R. M. Easley

Central Station Dept.,
General Electric Co.

HYDROGEN-COOLED synchronous condensers have been in operation more than seven years, and there is an increasing interest in the use of hydrogen for ventilating rotating electrical machines. It may, therefore, be of interest to review why and how hydrogen cooling is used and to summarize operating experience.

Characteristics of hydrogen that makes it an efficient ventilating medium are: It is the lightest known substance; it has high thermal conductivity; and its coefficient of surface heat transfer is higher than that of air.

Density of hydrogen is approximately 7% that of air. Since windage losses are directly proportional to the density of the gas, the losses caused by a body rotating in hydrogen are only 7% of those for a body rotating in air. In atmosphere of 97% hydrogen and 3% air, the windage is approximately 10% of what it would be in air. This decrease in losses naturally reduces the amount of heat to be removed from a machine.

Thermal conductivity of hydrogen is about seven times that of air. Consequently, heat passes across small spaces between insulation and core and between the laminations themselves much more readily than with air-cooled machines. As a result, for a given heat transfer the temperature rise from core surface to the copper is less in hydrogen than in air.

In passing over a heated surface, hydrogen will pick up 30% more heat than air for a given temperature drop. Similarly, in passing over the coolers, hydrogen will give up more heat for the same temperature drop.

Increased Output

These characteristics of hydrogen permit an increase in electrical-machine output for a given core or physical size, or the use of a smaller core for a given output.

A factor tending to further reduce the installed cost of a hydrogen-cooled machine is that the shell is gas-tight. This makes it inherently suitable for outdoor installation. It is, thus, sometimes possible to credit a hydrogen-cooled machine with an appreciable saving in building cost.

Quietness of the hydrogen-cooled machine may make possible an additional saving in installed cost in some cases. Decreased windage loss reduces windage noise and the enclosure prevents gas-borne noises. Hydrogen-cooled machines are, therefore, much quieter than air-cooled units. This allows locating these machines in neighborhoods where air-cooled units would be prohibited. Locating a machine more advantageously with respect to load may mean a saving in cost of lines.

Where all of the foregoing factors are favorable, it is possible that the installed cost of a hydrogen machine may be less than that of an air-cooled unit.

Saving in operating costs is a paramount advantage of hydrogen-cooled machines. First, it reduces the windage losses by approximately 90%, which is partially offset at higher values of load by increased copper losses. An appreciable saving is obtained at all loads and it is this saving that justifies the use of hydrogen in most cases.

Operating costs are also reduced by decreased inspection and maintenance expense. The gas-tight enclosure keeps out all foreign matter so that the windings and ventilating ducts remain clean. Hydrogen prevents damage that might occur in air if corona were present in the machine and the gas will not support combustion. For these reasons danger of short circuits is greatly reduced and all danger of fire is eliminated. Furthermore, the bearing oil will not oxidize or sludge.

Based on an inspection made after 13-mo. operation, a large power company, which has pioneered in the use of hydrogen-cooled condensers, schedules its inspections at 5-yr. intervals. After its first inspection, one machine was operated about 5.5 yr. without opening the main shell. The collector housing should ordinarily be opened up at about 3-mo. intervals to inspect brushes and remove carbon dust. A seal is closed between this housing and the main shell before the collector housing is opened so that only the small quantity of gas in the housing itself is lost.

Although many years of operation will be required to demonstrate the fact, it seems safe to predict an unusually long life with remarkably little inspection and maintenance expense for these machines.

Danger of a hydrogen explosion has been advanced as an argument against hydrogen cooling. Fear of this is rapidly diminishing with increased knowledge. Hydrogen is used extensively and successfully in many industrial processes such as brazing, annealing, welding, etc., where the potential chances of an explosion are greater than in an electrical machine, due to contact with air. In electrical machines air and other contaminations are excluded.

A mixture of air and hydrogen will not explode if it contains less than 9.5% or more than 74% of hydrogen by volume. The explosive range is then from about 10% hydrogen and 90% air to 75% hydrogen and 25% air. While filling or emptying the shell scavenging with an inert gas (CO_2) prevents getting an explosive mixture of hydrogen and air thus eliminating the danger of an explosion. The shell is first filled with

CO_2, which is then replaced by hydrogen. Once the shell is filled with hydrogen, purity of the gas is readily maintained by operating at a pressure above atmosphere, so that any slight leakage will be outward. When the pressure drops to a predetermined value, commercially pure hydrogen is automatically fed in by a pressure controlled valve. Make-up hydrogen to replace leakage from a 15,000 kva. condenser has been estimated to amount to a cost of 10c. per day.

Although the danger of an explosion is admittedly remote, it may be worth while considering what the results would be. The total energy available of hydrogen in the shell of a 15,000-kva. condenser, containing the most explosive mixture of air and hydrogen is about equivalent to that contained in 7 lb. of coal. With this mixture at approximately atmospheric pressure and starting with normal operating temperature, it is estimated that the explosive pressure can not exceed 100 lb. per sq.in. The product of the explosion is water and unless its temperature is maintained by a continuing input of energy, condensation and consequent reduction in pressure will occur.

Tests have been made on the shells of hydrogen-cooled condensers using the most explosive mixture of air and hydrogen at atmospheric pressure. The charge was ignited with a spark plug and an instantaneous maximum pressure of 85 lb. per sq.in. obtained, followed immediately by a partial vacuum, eliminating any tendency of the structure to explode. If the machine had been completely assembled heat adsorption would have held the instantaneous pressure down to probably not in excess of 50 lb. per sq.in.

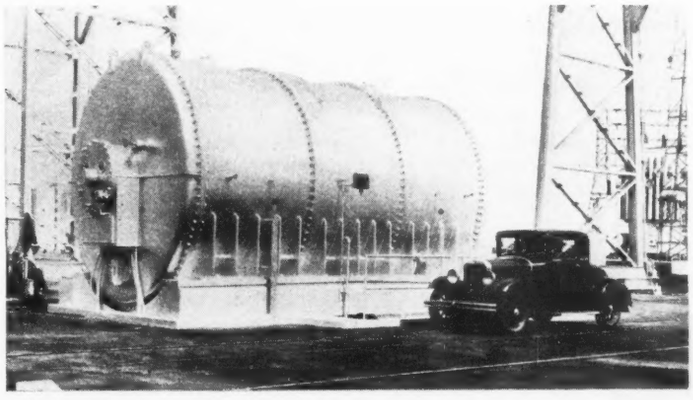
A homologous container was tested to failure and although the shell cracked, there was no outward explosion of parts. A vacuum was established so rapidly that there was no apparent time lapse between the explosion sound and hissing noise caused by air being sucked through the crack in the shell.

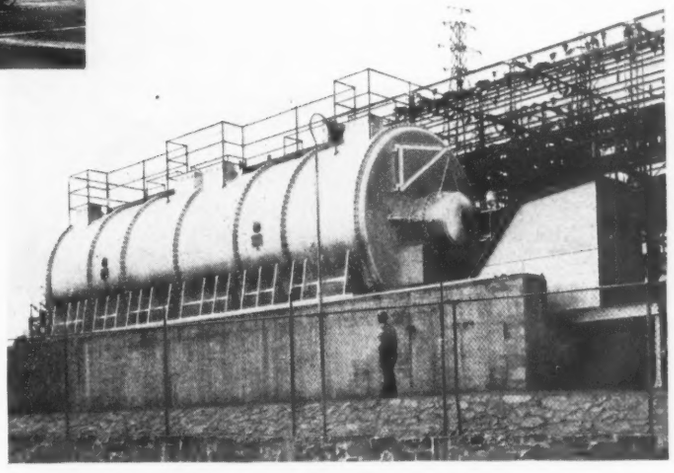
Using hydrogen as a cooling medium entails several problems of a mechanical nature. The necessity for a gas-tight enclosure led to a cylindrical shell made up of the necessary number of sections to facilitate handling. Gas coolers in the shell cool the hydrogen as it passes from the machine discharge to the intake. Usually four coolers per machine are employed, arranged one on either side of the shaft at both ends of the machine. The coolers are mounted vertically with the connections tied in to the shell to bring all water connections into the pit beneath the unit.

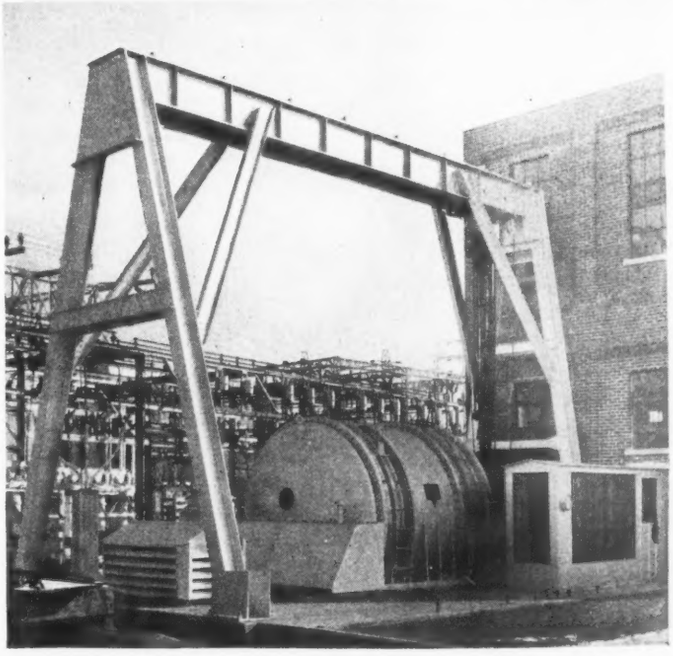
All other piping is arranged so that it comes out of the shell into the pit, as do the machine leads (which are brought through the shell by means of bushings), leads to bearing-temperature relays and resistance-temperature detectors, bearing-thermometer tubes, etc.

The large number of brushes on the exciter with their problems of brush dust and brush maintenance would require a separate compartment with shaft seal if the exciter were direct connected. The brushes on a direct-current commutator may normally require attention at shorter intervals than do collector ring brushes. To avoid the extra expense and complications by direct connected exciters, hydrogen-cooled machines have motor-driven exciters.

As previously mentioned, decreased losses and improved ventilation obtained in hydrogen permit an increase in rating







Left—The largest hydrogen-cooled synchronous condenser in operation, rated at 50,000 kva., is on the Southern California Edison Co.'s system at La Fresa, Calif. Below—Hydrogen-cooled 20,000-kva. frequency converter installed by Pennsylvania Power & Light Co. Botton—This 20,000-kva. hydrogen-cooled synchronous condenser installed by the Appalachian Electric Power Co. was closed for 5.5 yr. after its first inspection

for a given size core, to the extent that this is determined by heating. There are other factors, such as, lagging capacity of condenser, pull-out torque of motors and short-circuit ratio of generators which, not being functions of heating, do not change with hydrogen enclosure. These therefore, determine to a large extent the amount which it is feasible to increase the output of a given core. It will be realized that increasing the output increases the copper losses, offsetting to some extent the saving in windage losses. This introduces a problem in economics (varying in importance with the load cycle and evaluation of losses) as to how far it is desirable to go in increasing the output.

In general, hydrogen-cooled condensers will show a saving in losses over air-cooled units of 12 to 15% at full load and approximately 45% at no load. In the slow-speed frequency converters, this saving will be approximately 10% at full load and 30% at no load.

Electrical operation of hydrogen-cooled machines is no different from that of air-cooled units. The chief problems of a special nature are those involved in filling with hydrogen, maintaining hydrogen pressure, and discharging the hydrogen.

The General Electric Co. built the first hydrogen-cooled synchronous condensers installed in this country. These machines have been in operation over 7 yr. and have given highly successful service. This company has now in operation ten hydrogen-cooled condensers having a combined capacity of 207,500 kva., with the largest unit rated 50,000 kva. A 20,000-kva. hydrogen-cooled frequency converter has been in operation for some time.

The foregoing applies specifically to comparatively low-speed salient-pole-type units used for synchronous condensers and frequency-converter sets. The problems of applying hydrogen cooling to the high-speed turbine-type generators are quite different. A considerable amount of interest is now being shown in turbine-generator applications and several orders have been placed. It will be a few years, however, before actual operating data will be available on these machines.

BULGING IN WATER-TUBE BOILERS

By R. O. Billings

BULGES in the tubes of a water-tube boiler may be found in tubes exposed to radiant heat, such as the two bottom rows of the boiler and in water-wall or slag-screen tubes. They often prove dangerous and may result in a more or less violent rupture unless precautions are taken. Such a tube failure often causes serious damage to the boiler from overheating.

How serious the bulge is should be determined by someone thoroughly familiar with such conditions. If the metal has stretched enough to cause appreciable reduction in tube thickness, the tube must be renewed. In less serious cases, the bulge may be driven back with a heavy- short-handled, striking hammer. Practice has shown that working the metal cold gives better results than heating, except with very heavy-gage tubes. If operation is continued without driving back the bulge, it provides a pocket for loose scale or sediment. Subsequent overheating and bulging will result.

Overheating of tubes, caused by internal scale or sludge deposits, is a common cause. Soluble or suspended solids may be reduced by more frequent blowing-down. A continuous blowdown system is often of great value in such cases. Scale adhering to the tubes should be removed by mechanical cleaning, at least, from the tubes exposed to radiant heat, and further formation prevented by proper treatment of boiler water. A competent feedwater laboratory will make analysis and recommend proper treatment.

A second cause is overheating of the metal due to oil or grease in the boiler. Oil is usually found in installations where returns to the feedwater system include condensate from reciprocating-engine exhaust. Excessive or improper oil, absence or neglect of a proper oil separator and insufficient oil-separator capacity are among the causes of oil passing into the boiler. Where oil separators are provided, a common error is to bypass them during cleaning, allowing the oil in the returns to pass directly into the boilers, whereas the returns should be wasted during such an operation. Oil should be removed from the boiler by boiling out with soda ash or caustic soda.

Formation of steam pockets is the third cause of bulged tubes. Again the actual bulging is due to overheating. These steam pockets are always due to retarded circulation. Although faulty design will cause this condition, operation is usually the primary cause. In a water-tube boiler of either the box-header or sinuous-header type a considerable amount of sludge, mud and sediment may collect at the bottom of the headers, especially at the rear. If this accumulation is not removed by frequent blowing down and periodic cleaning through the handhole openings, the deposit may build up to a depth sufficient to obstruct the ends of the lower row of tubes. This will cause the water in this row to boil out faster than the cooler water can enter the rear ends. Steam pockets and overheating results.

A fourth and rare, cause of bulged tubes is excessive pressure for the thickness or gage of the tube. Boiler codes give standard thickness to use for various pressures, and these limits should be carefully maintained.

In some cases an apparent bulge will be found on a tube. When this is struck with a hammer it will break, and solid metal appears under the break. This is not a bulge, but a blister. It is caused by defective material, such as slag rolled into the metal, forming layers called laminations. The insulating qualities of this slag or air space isolate the outside layer of metal from the cooling water within. It is most serious where the blister causes an appreciable reduction in tube thickness. In these cases the tube should be renewed. When the blister is just a "skin effect," the weakening is negligible, providing a second blister does not develop.

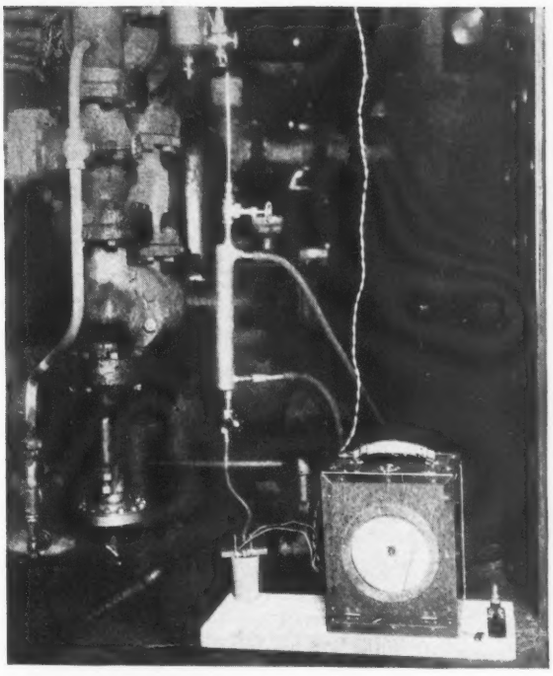


Fig. 1—Instrument records conductivity of steam condensed under pressure

Treat Feedwater To Prevent CARRYOVER

By S. E. Tray
Allis-Chalmers Mfg. Co.
Feedwater Treating Dept.

DESPITE advances in feedwater treatment during the last decade, the production of clean steam for turbines and process is still a major problem of power-plant operation. Considerable research by boiler manufacturers has led to improved circulation and better distribution of steam liberating surfaces. In addition, various types of steam scrubbers have been recommended for some of the new high-pressure installations, and steam separators find a wide field of application. These mechanical devices are valuable as an aid to clean steam, but do not eliminate the causes of carryover. Likewise, in numerous existing plants there is no space for the installation of this equipment without a major capital investment.

In most cases, carryover can be traced directly to boiler water conditions. The selection of proper treatment thus becomes an important factor in the production of clean steam. Carryover has been eliminated in many plants simply through a change in water treatment without recourse to change in design or circulation of the boilers. This emphasizes the importance of adapting the treatment to the boiler, rather than designing the boiler to fit a standard type of treatment without regard to local operating conditions.

From the standpoint of turbines, their continued and efficient operation depends on a supply of steam free from entrained boiler-water salts and corrosive gases. Turbine-blade deposits, affecting as they do the contour of the blading, lower the efficiency and, by restricting nozzle and blade areas, limit machine capacity. Corrosive gases in steam include oxygen, carbon dioxide, hydrogen sulphide, ammonia and organic acids. Their presence is nullified in part through the use of corrosion-resisting alloys wherever possible in the turbine, but machines of earlier manufacture often do not have this protection. The problem is one of first determining the steam conditions and then changing the water treatment to produce the proper quality of steam.

One of the simplest methods of determining the presence of boiler-water salts in the steam consists of measuring the conductivity of a sample of condensed steam. The electrical conductance of condensed steam is proportional to the dissolved solids in solution. Although dissolved gases also affect conductivity, their influence with any given treatment is fairly constant. Thus relative measurements can be made without compensating for the presence of dissolved gases.

Conductivity Apparatus

The apparatus shown in Fig. 1 has been developed for this purpose and consists essentially of a recording voltmeter in series with electrodes immersed in a sample of condensed steam. Steam samples may be taken in the main header just ahead of the turbine throttle valve, or between the boiler and superheater if saturated steam conditions are to be studied. Steam is condensed under pressure in a brass cooling coil and discharged continuously through glass tubing between two nickel electrodes. A continuous record of conductivity is then available and the presence of carryover is shown by variations in the curve. Comparison of the curve obtained with a similar curve for distilled water gives an indication of the quantity of impurities.

Fig. 2 shows a typical chart taken from steam entering a 600 lb. non-condensing turbine over a 24-hour period. The variations in the curve on this chart indicate the presence of dissolved solids in the steam. Peak conditions correspond to maximum carryover periods and, when compared with a base line of 100 for distilled water, show considerable solids in the steam over the entire day.

These conductivity measurements, together with analyses of turbine blade deposits, have been made over the past several years in a number of plants where carryover was a problem. Analyses of blade deposits under varying operating conditions are given in Table I.

From these analyses it is apparent that one of the chief constituents of turbine blade deposits is sodium hydroxide. Silica also appears uniformly in a majority of

Table I—Composition of Turbine Blade Deposits, Per Cent

	Steam Pressure—lb./sq.in.—			
	600	400	400	250
Silica (SiO_2)	22.6	3.2	19.3	17.6
Alumina (AL_2O_3)	17.3	5.8	2.0	6.9
Iron (Fe_2O_3)	3.2	1.8	1.2	0.5
Sodium oxide (Na_2O)	25.1	27.3	56.3	22.1
Calcium oxide (CaO)	10.4	16.8	1.9	19.5
Magnesium oxide (MgO)	trace	8.2	0.5	4.7
Sulphuric anhydride (SO_3)	0.5	....	1.6	1.1
Phosphate (P_2O_5)	3.2	....	....	11.5
Loss on ignition	17.6	36.9	17.2	16.1

cases and may exist as pure, insoluble silica or as a soluble silicate. Other boiler-water salts are present to a smaller degree and there are evidences of aluminate and phosphate where they have been used in feedwater treatment. Investigations have covered plants with and without continuous blowdown, with varying percentages of makeup water, and with both internal and external treatment of feedwater.

High Alkalinities

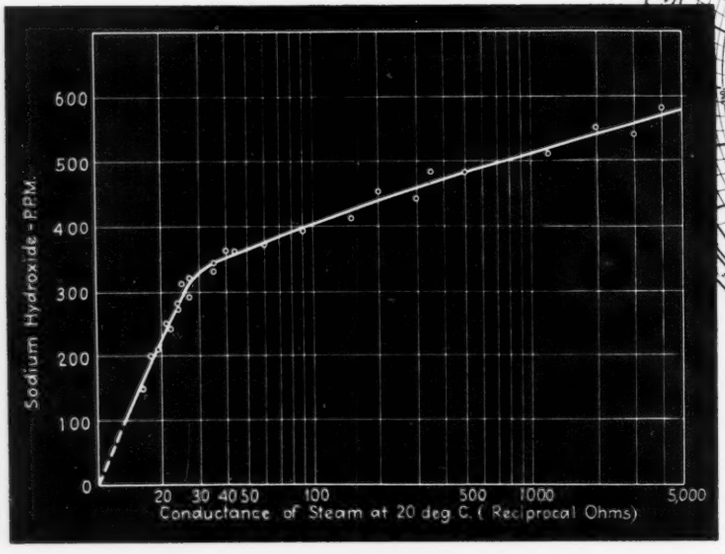
One factor common to practically every case of carryover is the presence of high alkalinities in the boiler water. The term "high alkalinities" is used here in a relative sense, that is, the alkalinities were high in relation to the total concentrations. These excessive alkalinities are generally the result of chemical treatment designed to maintain scale-free boilers. This fact, together with the universal presence of sodium salts in the blade deposits, has led to a consideration of the effect of alkalinities on carryover. Mumford[1] in 1929, published data in support of this theory. Subsequent investigations by Straub[2] in 1935 further established hydroxide concentrations as an important factor in carryover. Suspended solids, total dissolved solids, water levels and load demands likewise contribute to carryover in the steam, but to a much smaller degree than alkalinity concentrations.

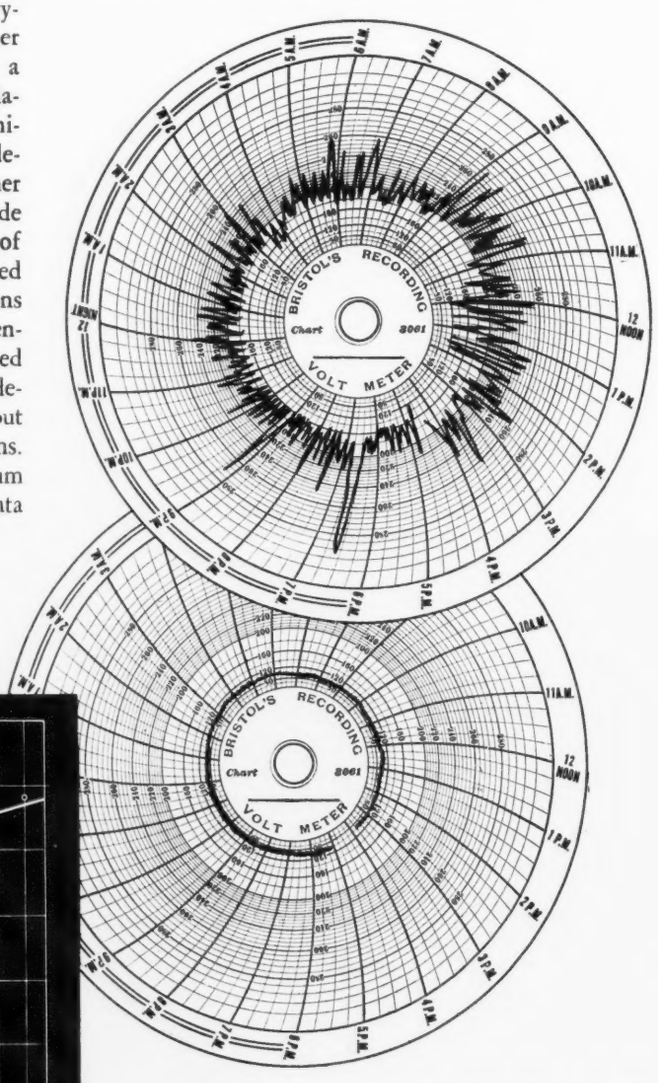
To illustrate the method used to determine maximum alkalinities that can be carried without carryover, data are presented from a 400-lb. 4-drum bent-tube boiler. Conductivity readings were obtained continuously on steam from this boiler under constant load conditions over a wide range of hydroxide concentrations. Fig. 4 shows the relation between the purity of the steam and boiler-water alkalinity. Above a critical value of 300 ppm a slight increase in hydroxide concentration results in a large increase in the solid matter in the steam. Below this value the curve breaks sharply and the steam has a conductance equivalent to distilled water. Although this critical concentration varies with different type boilers, similar results have been obtained from other designs and the shape of the curve remains essentially the same.

If operation with low alkalinities will produce clean steam, the problem appears simple enough, except for the fact that silica scale and corrosion become troublesome at low alkalinities. To overcome this difficulty, the use of certain iron products has been found quite effective in controlling boiler water treatment. These iron products permit operation at low alkalinities and in their

[1]Trans. ASME—FSP 51-47, 1929.
[2]Trans. ASME—FSP Nov. 1935.

Fig. 4 (Below)—Above a critical value of 300 p.p.m., a slight increase in alkalinity causes a large increase in carryover





Figs. 2 & 3—Conductivity charts before (Top) and after (Bottom) the starting of supplementary iron treatment of boiler water. Steam pressure, 650 lb.

presence silica is thrown out of solution and prevented from depositing as scale. At the same time, corrosion is prevented by the absorption of oxygen by the iron. Thus the necessity for high alkalinities is removed and, through the use of such iron products as a supplementary treatment, the generation of clean steam is made possible. The coagulating properties of iron products are well known through their use in municipal water clarification for a number of years. In boiler water also, coagulation with iron results in reducing the amount of suspended solids, which further acts to prevent carryover.

Effect of Treatment

The effect of supplementary iron treatment is illustrated in Fig. 3, which shows a conductivity chart from the plant illustrated in Fig. 2 after a change in boiler water treatment. The curve approximates the base line for distilled water and is uniform over the 24-hour period. Such results have been duplicated in a number of plants under widely varying operating conditions.

The two principal corrosive gases found in steam are carbon dioxide and oxygen. The effect of iron on the removal of oxygen has already been indicated. Steam always contains some carbon dioxide, as the result of boiler water alkalinities. Any reduction in alkalinities, therefore, means less carbon dioxide in the steam and less corrosion in the turbine. This is desirable not only from the standpoint of turbine corrosion but for the protection of heating mains and condensate returns as well.

Further Research

The effect of the iron products considered on surface tension, bubble formation and other factors which may influence carryover is not apparent at this time. Investigations to date have been concerned principally with plants having high makeup requirements, using chemical treatment of feedwater. Further research in the central station field is expected to result in additional information of importance in improving turbine operation and availability.

The iron products referred to above, as developed by the Allis-Chalmers Mfg. Co., are in a finely divided condition, dispersed in water.

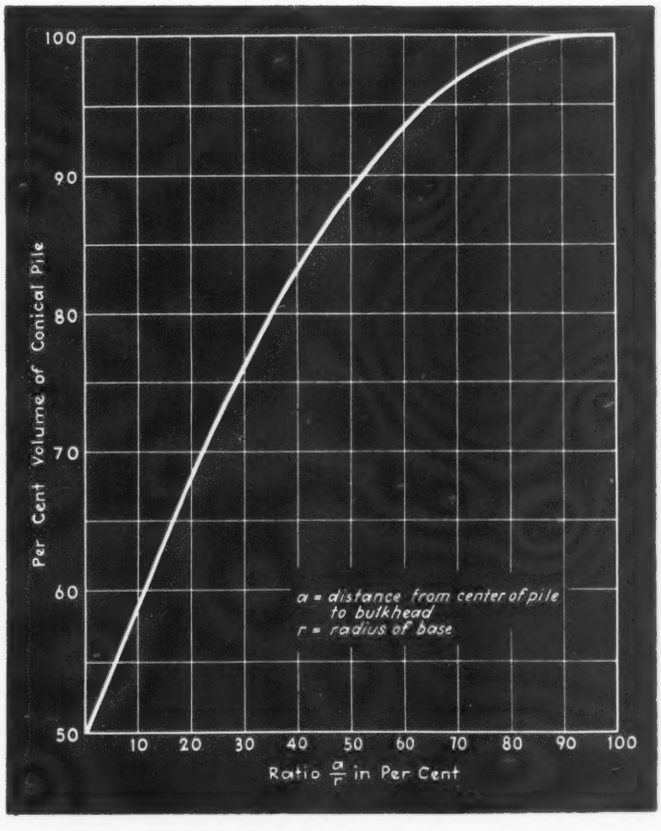
HOW MUCH COAL IN A CONICAL PILE?

By F. F. Hough

IN MAKING reports on the amount of coal in storage yards, the calculations are sometimes complicated, because the storage pile may be against a wall or bulkhead. Where such piles are in the form of a cone the quantity can be determined from the accompanying curve.

The curve shows the volume of the pile in percent of the volume of the cone without the bulkhead, for various values of the ratio A/R, where R is the radius of the pile at its base, and A the distance from the bulkhead to the center line of the pile.

To use this curve, proceed as in the following example: To find the tons of coal in a pile 20 ft. high having a base diameter of 50 ft., piled against a bulkhead 10 ft. from the center of the circular base. The value of A/R is 10/25, or 40%. From the curve we find that for a 40% ratio the pile will have a volume 83.1% of the volume it would have if the bulkhead were not there. The volume of the pile without the bulkhead is found from the equation $V = \pi \frac{r^2 h.}{3}$ Substituting in this equation, we find the volume V equal to $\pi \times 25^2 \times \frac{20}{3} =$ 13,100 cu.ft. which, multiplied by 83.1% gives 10,900 cu.ft. as the volume of the coal storage pile. One ton of bituminous coal occupies about 40 cu.ft., so in the storage pile there will be 10,900 ÷ 40, or 273 tons.



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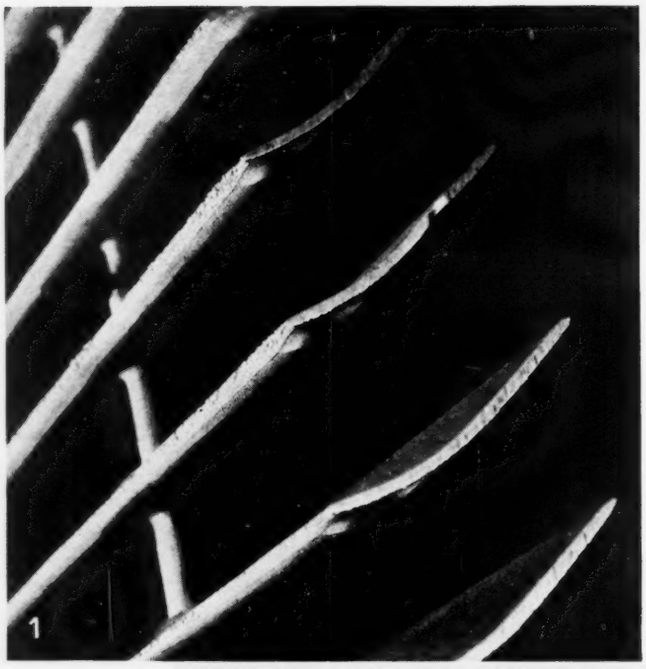

Fig. 1—Blade surfaces are free of scale, lashing wires clean and blades in excellent condition. Inlet edges show medium heavy erosion, but not of a nature to cause concern. Erosion is uniform, free from deep notching, and typical of erosion present on stainless steel blades. There has been a light tip rub on profiles, illustrating clearly the reason for profiling and shows the comparative rubbing areas presented.

Fig. 2—Blades of 5% nickel attacked by oxygen corrosion. Undermined sections at the lashing wires together with reduced sectional area at points of highest stress have made these blades dangerous to operate. Blades in this condition should be removed

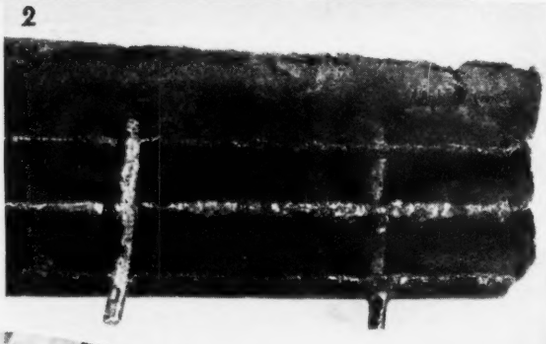

Fig. 3—Blades in this condition obviously must be replaced

Fig. 4—Inlet tip erosion on large low-pressure blading. This is not considered at all dangerous, the stresses present being more or less those set up at the lashing wires. Blades most heavily eroded are those where the inlet edge protrudes beyond the remainder of the blades.

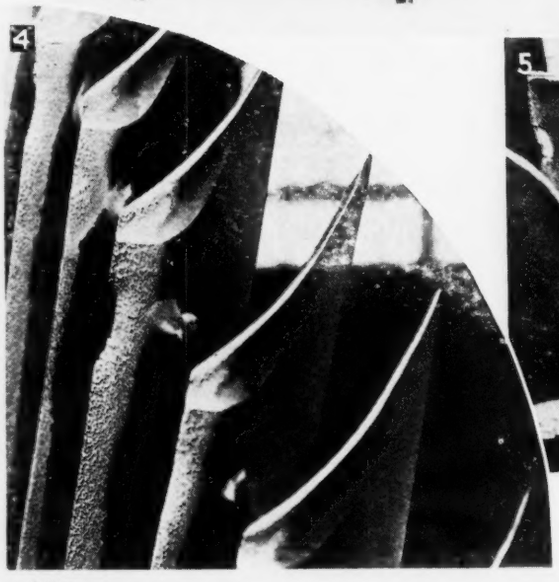

Fig. 5—Heavily corroded 5% nickel blading, where the corrosion behind the lashing wire has made the lashing insecure, should be renewed. Note the deep pitting behind wires on concave surfaces. Very often blading in this condition is brittle and fractures easily

Fig. 6—Local undercutting produces eccentric loading and presents an excellent possibility of failure. Erosion as seen near blade tips is of little importance

Fig. 7—Shows how fatigue cracks start at notches caused by heavy erosion. Eroded locally, blading is far more susceptible to failure than when edges have been eaten away more or less uniformly over the length of the blade. Erosion of this latter type can be ground out and possibility of failure greatly reduced

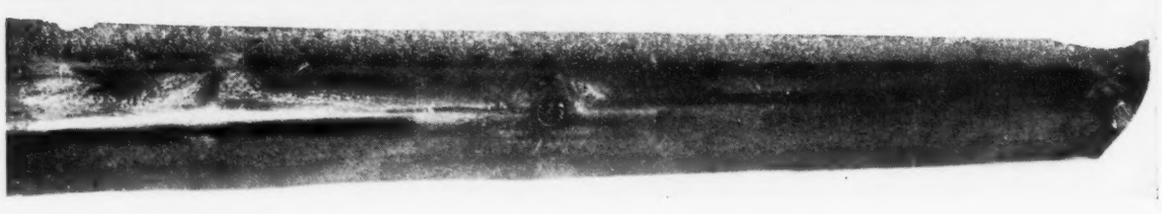

Fig. 8—Notches on outlet edges where sectional area and shape change, reduced sectional areas, embrittlement of material due to operating conditions make blades in this condition a risk to operate

REBLADE TURBINES

By W. H. Lloyd,
Turbine Blading Engineer
Westinghouse Elec. & Mfg. Co.

UNDER favorable conditions turbine blades last for years and even under unusual operating conditions blades often resist corrosion and erosion for a long time. Yet they have been the largest single cause of turbine outage. Research and operating experience have proved that blade failures are almost always due to variable bending stresses produced partly by steam loads and partly by additional stresses imposed by blade vibration.

Flow conditions demand blade shapes that are unfavorable from the point of view of stress. So to reduce bending stress lashing wires are silver-soldered or welded to the body of the blades. Broken wires and sections undermined at lashings should, therefore, be given particular attention upon inspection.

Decision as to when to reblade is subject to considerable difference of opinion. There are, however, certain major causes such as heavy tip rubs, erosion, sections undermined by corrosion, loose lashing, excessive vibration, brittle materials, etc. which experience has shown are the usual causes of failures. The photographs illustrate blading in various stages of wear. The captions indicate the seriousness of the conditions shown and whether or not the blades should be removed and new ones substituted in their place.

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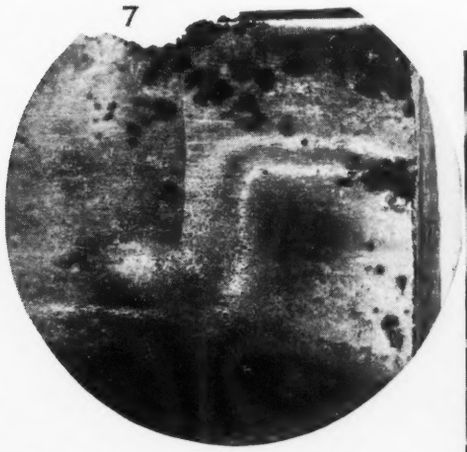

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Fig. 9—Iron corrosion present on 5% nickel. Scale-like surface corrosion flakes off during operation, gradually eating through as in the center blade near the tip. Lashing wire bond is sound, blade surfaces generally rough. Blading in this condition offers no risk. Tips could be renewed by soldering if desired. Fig. 10—A type of blade found at about the center of the spindle on large units. In this location, where failure would wipe out numerous blade rows in both spindle and cylinder, this type of corrosion is dangerous and blading in this condition should be replaced

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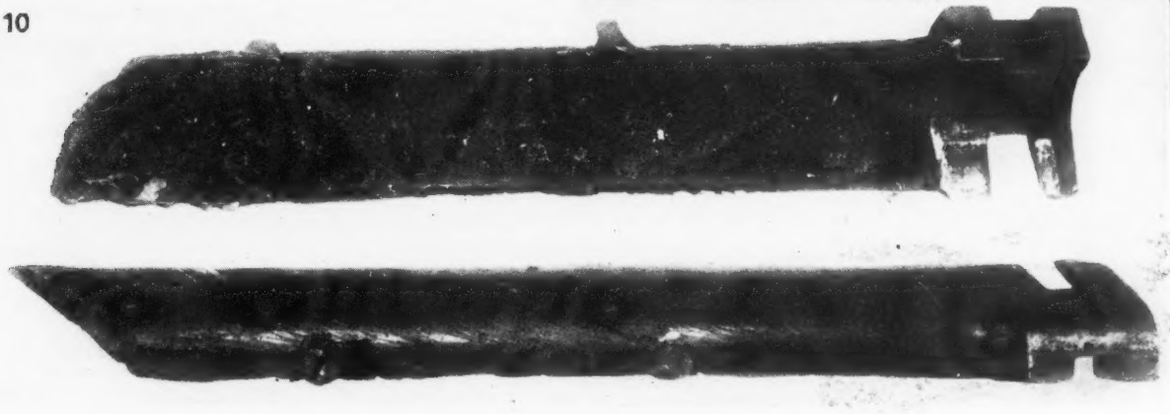


RAMBLES OF AN ENGINEER

II—Dresden ... Prague ... Vitkovice ... Nuremburg ...

New power ideas are afoot in the old world. Here[1] are side lights on men, machines and movements that will touch the jobs of power engineers in America

THIS second installment of my "rambles" should perhaps be entitled "Hitting the High Spots." Leaving Berlin early Saturday morning, March 14, I had an unbreakable engagement in Zurich, Switzerland, on March 19. Squeezed between these inflexible limits were the six important stops listed in the heading of this article. I just kept moving and saw what I could.

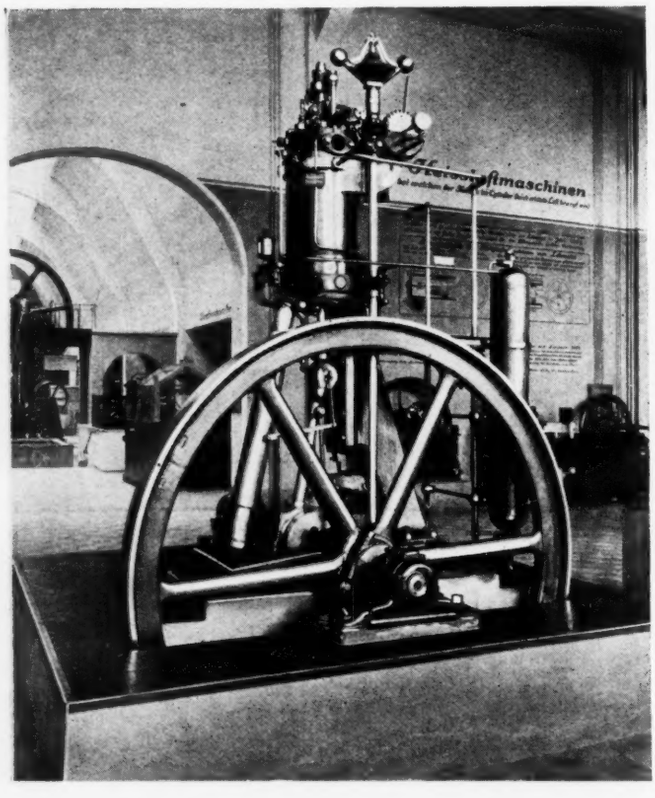
Director Schultz and Dr. Dennies, hospitable friends in Brown-Boveri's Leipzig office, brought car and chauffeur down from Leipzig to speed me around Dresden, sedate and beautiful city of Saxony. Aside from the impressive sights of the city, Dresden is of interest because of its very fine Technische Hochschule, where I had a profitable session with Dr.-Ing.-Prof. Pauer.

Expert in power economics, Prof. Pauer told me that the larger industrial plants in Germany can buy electricity at low rates and often find this cheaper than making their own. (This, of course, does not apply to large process and chemical plants.) On the other hand, many small plants find it economical to generate their own power, particularly where they need process steam. Many plants buy all their power in summer when rates are lowest, in winter making part or all of their requirements as a by-product. Some of the big German process plants sell excess power to the privately and publicly owned central stations.

Leaving Dresden, I shot down to Prague, capital of the ancient country and young republic of Czechoslovakia. There is a town worth crossing an ocean to see. Nothing remotely like it in the United States. Buildings still serviceable range up to 1,000 years old, and you find crooked streets full of houses and shops that have been in constant daily use for from 300 to 600 years. Prague is one of the most picturesque spots in Europe, but it was Sunday and I saw nothing of engineering interest there—nothing but fine old buildings, crooked streets and a majestic river bank.

[1]The first installment, "Men and Machines in Germany," appeared in May.

Munich: World's No. 1 diesel engine (1898) in the Deutsches Museum



East to Vitkovice

The technical angle of Czechoslovakia I saw in Vitkovice (the Germans call it Witkowitz), part of the city of Moravska Ostrava, about 200 miles from Prague in the general direction of Russia. There I visited the great Vitkovice Mines, Steel & Iron Works Corp. After spending the night in the company hotel, and dining on goat's meat and Pilsener beer, I visited the Loeffler boiler installation at the Caroline mines of this company and then the nearby Trebovice power station of the Morava-Silesian Electricity Co. I also interviewed my hosts on the accomplishments and possibilities of this interesting boiler (product of the Vitkovice works). The following comments are based on what I already knew of the Loeffler boiler, plus what I learned by looking at the installations, and by talking with Director Spitzer, General Director Federer, Mr. Belohlavek and others.

In case you don't remember just how this novel steam generator works, here is the story in brief. Remember first that what looks like the boiler is not a boiler at all, but merely a big direct-fired superheater through which steam is circulated at high velocity by a centrifugal pump. Leaving this superheater at perhaps 1,900 lb. pressure and 950 deg. F. temperature, the hot steam is bubbled through the water in a drum called an "evaporator," losing its superheat and thereby evaporating some of the water. Thus, the amount of saturated steam coming out of the evaporator always exceeds the amount of superheated steam going in, and this difference is the boiler output.

The chief advantage claimed for the Loeffler system of steam generation is that distilled feedwater is not required, since tubes exposed to furnace or flue gas contain only steam.

Like all American visitors, I asked "How about the

Vienna . . . Munich . . .

By Philip W. Swain
Editor of POWER

steam circulating pump?" They told me that it never gives any trouble, which seems reasonable because the pump (made by Escher Wyss, Switzerland) is a simple overhung single impeller and has merely to raise the pressure a few pounds to induce circulation. Steam temperature is kept constant by controlling the speed of the circulating pump. Firing rate controls steam pressure. Another claim for the Loeffler boiler is that the evaporator drums act as accumulators.

As built today in Vitkovice, the superheater is in two sections, radiant superheater surrounding the furnace and convection superheater above. Headers are simple steel tubes without hand holes. The small superheater tubes are butt-welded to nipples hydraulically forced out from the header tubes. Welded construction, they told me, is absolutely essential for the pressures and temperatures encountered. The whole unit, including radiant and convection superheaters and economizers, is a system of welded tube coils and tube headers.

I asked the usual questions about what would happen if the circulating pump should stop, or the steam flow should be cut off suddenly. In the former case, they said, the generator is vented to the atmosphere, and the evaporator (acting as a steam accumulator) keeps steam flowing through the coils until the furnace heat can be reduced. On the other hand, when the steam demand is suddenly cut off, the safety valves open and produce the same effect.

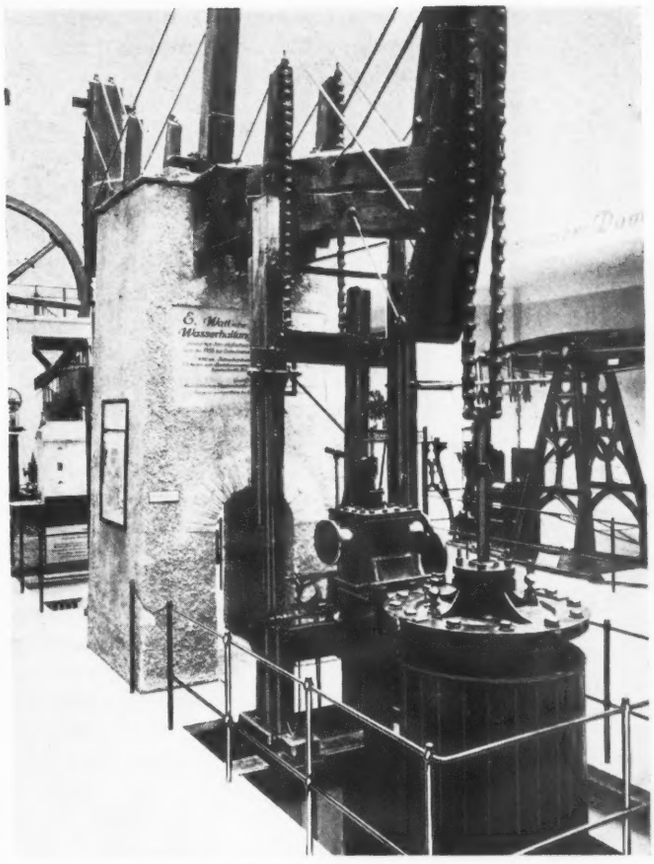
The Loeffler installation at the Caroline Pit and Trebovice were fine-looking, particularly the latter. Caroline mixes 70% of fines from the mines with 30% of coal sludge from the washers and fires this mixture after drying and pulverizing.

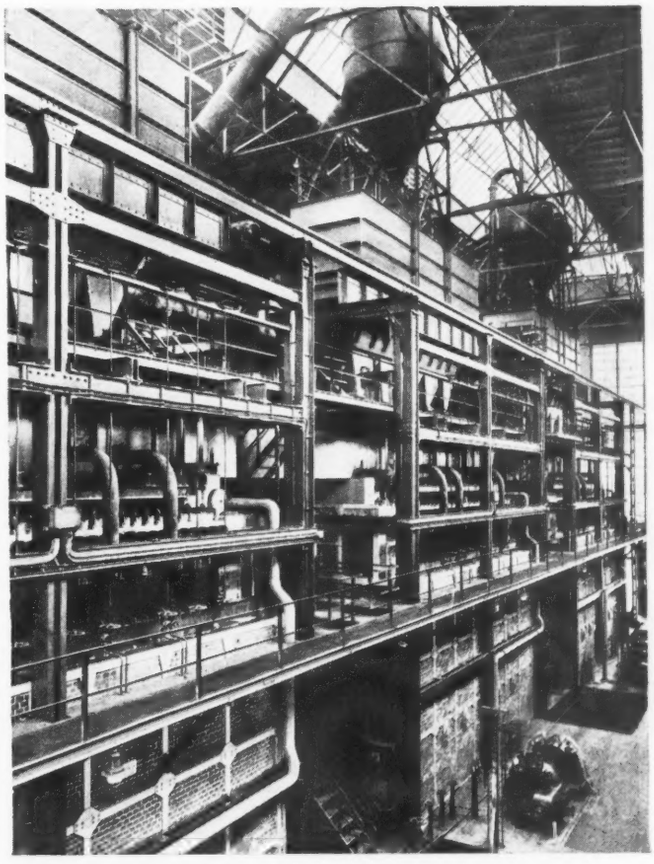
The three Loeffler boilers at Trebovice are each rated at 60 to 70 tons of steam per hr. The coal used runs 22 to 25% ash. When I was there, boiler No. 3 was delivering 60 tons of steam per hr. at 1,940 lb. pressure, 950 deg. F. Practically all Loeffler installations operate under approximately these conditions. The boiler is not suitable for low pressure or temperature.

It happened that a high-pressure turbine cylinder was open at Trebovice for renewal of the glands. The blades had not been cleaned, but I could see no traces of erosion or deposits.

Well, that's enough about Vitkovice, and it's probably just as well (for lack of space) that I have nothing to say about engineering developments at Vienna, the next stop. In Vienna it was mainly a matter of in for the night and out again for Nuremburg in the morning, in order to keep up with my high-pressure schedule.

As far as I could determine, however, Vienna is very





Top—Munich: This walking-beam engine, built in 1813, is now operated in the Deutsches Museum. Bottom—Vitkovice: The real "boilers" are under the floor. These are the coal-fired superheaters of the Loeffler steam generators in the Trebovice power station

quiet in a business way—in fact, it has been that way ever since the War broke up Austria-Hungary into smaller nations. Still, this great city would be a very fine place to live if one could find a living. Lots of wonderful people there.

Machines in Nuremburg

I shall not soon forget the all-day train ride from Vienna to Nuremburg, through the picturesque hill country of Austria and south Germany. It was "home sweet home." No American could be blind to the beauties of those rolling hills, clean trimmed rows of pine trees, farms placed neatly one after the other. And at the end of it all was old Nuremburg itself—a dream come true.

Getting an early start next morning, I was able to make a good visit to the "MAN" works, then see the high spots of the town and catch the afternoon train for Munich. "MAN" (Maschinenfabrik Augsburg—Nürnburg) is a strictly up-to-date appendage of this very ancient and picturesque city. Steam turbines, boilers, and automotive diesels are made in the Nuremburg factory. The large diesels are produced at Augsburg.

Ing. Koerber guided me through the erection sheds at Nuremburg. The largest turbine on the floor was a 16,000-kw. Ljungstrom radial-flow machine for a German chemical factory. This took steam at 1,700 lb. and exhausted to process at 30 lb.

Other high-pressure turbines in the MAN shop included a 1,400 to 1,700-lb. 1,000-hp. geared unit exhausting at 70 lb. gage, and a very compact rotor for a 1,000-hp., 5,000-r.p.m. machine.

I was greatly interested in a small vertical experimental two-cylinder steam engine designed to deliver 40 hp. at 1,000 r.p.m. and 1,400 lb. pressure. This was being developed for bus and truck use, but may have interesting possibilities in small industrial plants. On this matter of high-pressure steam engines I talked with Dr.-Ing. Englert. For high pressures, he pointed out, engines are practicable in much smaller sizes than are turbines. The combination of high pressure and small power puts the turbine designer in a hot spot; if he allows reasonable clearance a lot of dense high-pressure steam will get by without doing work.

Experiments with these small high-speed, high-pressure steam engines will be worth watching. Some will question the ability of a steam engine to withstand high steam temperatures, but here one should remember that a back-pressure unit requires a much lower initial steam temperature than does a condensing unit. Then, also, labyrinth sealed pistons (no rings) have been operated at fairly high temperatures without cylinder lubrication.

Nuremburg: From this neat kitchen of the "Bratwurstglocklein" meals have been served for the past 623 years

I came to the MAN plant without the formality of an introduction, but they showed me the typical German hospitality by furnishing a fine company car to drive me back to town. I say "back to town," because MAN, like most of the factories in this city of 400,000 inhabitants, is outside the walls of ancient Nuremburg. Most of these walls still stand—solid masonry, good for another thousand years or so.

In the quaint streets down by the river, the past comes to life. Building after building dated between 1300 and 1600, hundreds of them, all in use every day as homes, stores, inns and beer cellars. On their outside walls are statues of the Virgin, painted Madonnas, or the gold-figured names of owners long dead. And up the winding streets chugs a modern diesel tractor. The whole place is incredible.

One thing I shall not forget is sausages and beer for lunch in the "Bratwurstglocklein" ("Little Bell of the Roast Sausage"), a tiny lean-to on the flank of St. Moritz Chapel. It seats perhaps a dozen people; prices are low and sausages plenty good. Don't miss it if you ever go to Nuremburg. In this little place food has been served daily for 623 years. "Little Bell of the Roast Sausage" filled its first mug and platter in the year 1313; I don't think the place has changed much since then and I hope it never does. Here came famous artists and craftsmen of old Nuremburg—Albrecht Durer, Hans Sachs, Peter Vischer, Veit Stoss (wood carver), and so on. Those were the days when cobblers wrote poetry and ditch diggers competed for the prize of the Meistersingers. You need only go to the Germanic Museum to discover that old Nuremburg had more real artists per square foot—in wood, copper, brass, stone, paint and pottery—than any other spot on earth.

But good-bye to these ancient wonders; I had to go to Munich for a quick visit to the Deutsches Museum, and then on to Switzerland.

Munich's Museum

Really, it was a shame to treat that way the noble city of Munich and the world's greatest scientific museum (with the possible exception of South Kensington, England). My taxi reached the museum at 5 p.m., and it was scheduled to close at 6. They gave me an effiicent guide who quickly showed me the chief sights of the steam and diesel sections. Then I bought a guide book and a few photos and had to call it a day. What I didn't see covered acres of floor space.

Of what little I did see, most interesting was the full-sized working original of a German mine pump engine built in 1813. My guide threw a switch and started a creaking walking beam moving up and down. Another interesting exhibit was the world's first diesel engine (1898).

In the Franklin Institute, Philadelphia, we see today the American beginnings of a similar display. If you are ever in Philadelphia drop in there and look it over. You'll find it worth while.

Next month I'll talk about things seen, heard and felt in Switzerland.

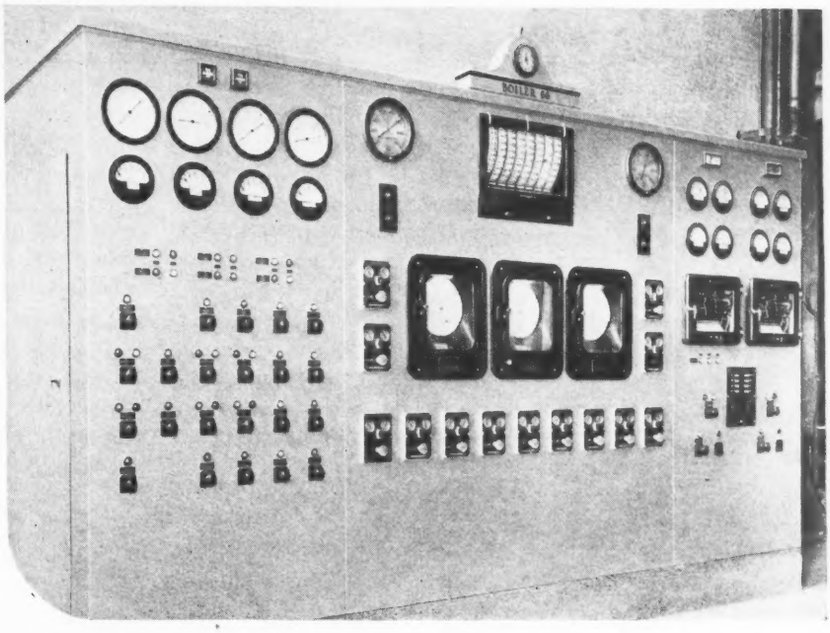


Fig. 1 — Operator has complete control of the boiler from this board

By N. J. Walker

Project Engineer
Division of Mechanical Engineering
Philadelphia Electric Company

COMBUSTION CONTROL AT RICHMOND STATION

WHEN the recent extension to Richmond Station of the Philadelphia Electric Co. was planned, provisions were made for a complete system of combustion control and automatic control of raw-coal feed to the pulverizers. To obtain a wide range of speed control for the forced- and induced-draft fans, they are driven by constant-speed motors through variable-speed hydraulic couplings. Couplings were selected after extensive research with one on a forced-draft fan on an existing boiler (See *Power*, July, 1934, page 398).

Equipment in the extension, in service now for over a year, has several interesting features. The main equipment comprises two 600,000-lb. per hr., 425-lb. per sq.in., 850-deg., B. & W. straight-tube, cross-drum boilers, pulverized-fuel fired, and a 165,000-kw. Westinghouse tandem-compound turbo-generator. The bin system of pulverized-coal firing has two pulverizing mills per boiler. Two fans per boiler, driven by squirrel-cage motors, provide primary air, one per boiler being a spare. Primary-air flow is controlled manually by motor-operated dampers independent of the mill or combustion-control system. Eight pulverized-coal feeders per boiler, driven by variable-speed d.-c. motors, feed fuel to the furnace through inter-tube burners. Two forced- and two induced-draft fans per boiler are driven by constant-speed squirrel-cage motors through variable-speed hydraulic couplings.

Fig. 2 is an isometric view of the coal-handling and pulverizing equipment for one boiler. Bailey Meter Co. automatic control regulates raw-coal feed to one mill and will be extended to all four in the near future. A central control board will be installed from which the mills will be operated. Coal feed from the bunker is automatically proportioned to air flow through the mill by two diaphragm-operated differential units, Fig. 3. One larger diaphragm D, is actuated by the pressure drop across an orifice in the air line between the cyclone collector and mill exhauster. A second, smaller, diaphragm, D_1 is actuated by the pressure drop across the mill-grinding element. The ratio of the diaphragm areas approximates the ratio of the differentials across the orifice and across the mill.

The two diaphragms exert forces in opposite directions on a common lever which adjusts a pilot valve. This valve establishes a loading air-pressure to regulate a piston-operated control drive on the feeder gate. If a pre-determined relation does not exist between mill differential and mill air flow due, for example, to a partially choked mill, the feeder gate is adjusted to correct this condition. Primary control pressure is determined by a selector valve. During automatic operation, primary control pressure may be changed in relation to the loading pressure to meet varying operating conditions by adjusting this valve. A change from automatic to hand control can also be made at will by the operator from this valve assembly.

Movement of the control-drive piston is obtained by air admitted to either end of its cylinder through a pilot valve, positioned by primary control pressure on a sylphon bellows attached to the valve stem. A tension spring connects the piston rod to the sylphon bellows. Once started, the piston continues in motion until spring tension equals air loading on the bellows, at which time the pilot-valve stem is restored to neutral and the piston stops.

A complete system of Bailey Meter Co. automatic equipment controls steam pressure and combustion conditions by regulating forced- and induced-draft fan

speeds and fuel supply, primarily from steam-header pressure. Forced and induced drafts are varied by changing fan speeds through Hydraulic Coupling Corp. hydraulic couplings. With this type of coupling an infinite number of output-shaft speeds can be had between about 20% and 98% full motor speed. This permits exact adjustment of draft as required, eliminating use of dampers, with a consequent saving in power.

No physical connection exists between the driving half or impeller of the coupling and the driven half, or runner, Fig. 6. Oil is the power-transmitting medium and is discharged by the pump action of the impeller directly against the vanes of the runner, which may be likened to a hydraulic turbine. Direction of oil flow through the two halves of the coupling is shown by the arrows. Reducing the quantity of oil in the coupling decreases the speed of the driven unit; increasing this quantity increases the speed.

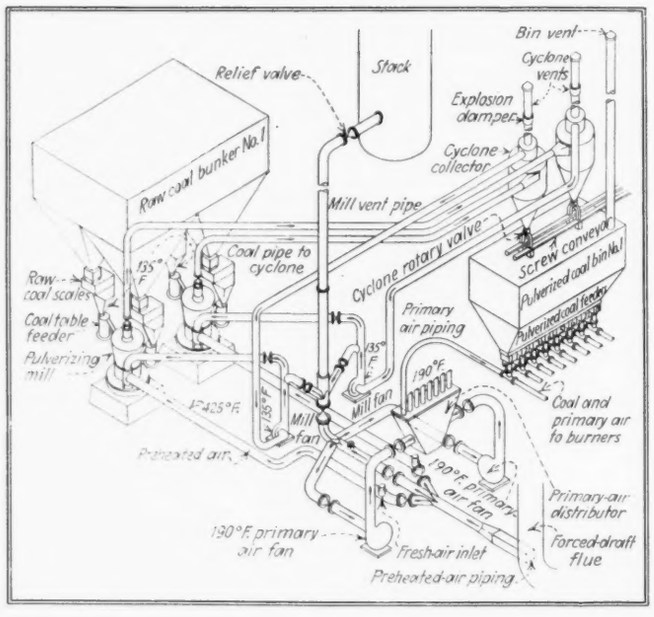
At Richmond, oil is supplied to or removed from each coupling by a motor-driven positive-displacement pump and control of diaphragm valves *A* and *B*, Fig. 6. Oil is pumped to or from the coupling under considerable head, resulting in quick response of fan speed to control-system impulses. Oil leakage from the port in the lower half of the coupling is discharged through the stationary scoop tube to the oil cooler, from which it is returned to the coupling. Spring-loaded relief valves *C* and *D* hold constant inlet and discharge pressure at the oil pump. By this means, a substantially constant pressure drop is maintained across the diaphragm valves so that, for a given valve position, a definite quantity of oil will be passed.

With valves *A* and *B* in such a position that each has the same opening with equal pressure drops across them, oil discharged from the pump merely circulates in the local oil circuit about the pump. If valve *A* should open slightly and valve *B* close a like amount, more oil will pass *A* than *B* can accommodate and the excess oil will be injected into the coupling to increase fan speed. When valve *B* is opened more than valve *A*, oil will be withdrawn from the coupling to reduce fan speed. Fig. 4 shows the hydraulic coupling and allied equipment on one of the induced-draft fan drives. The motor is at the right but the fan, installed outdoors, cannot be seen.

Fig. 5 is a composite diagram of the automatic combustion-control system and Fig. 1 gives a close-up view of one of the individual boiler-control boards. A master steam pressure-controller of the Bourdon-tube type connects to the main steam header. Increasing or decreasing demands for steam vary the header pressure which is the primary actuating force. The free end of the Bourdon tube connects to a pilot valve, movement of which varies the air-loading pressure through a master selector valve. Functions of the pilot valve and selector valve are similar to those for the pulverizer-feeder control, Fig. 2. In addition to the master selector valve, a selector valve is provided on each boiler control board for remote manual regulation of the induced- and forced-draft fan couplings, induced- and forced-draft dampers and the fuel-control drive.

The master pilot valve admits air-pressure impulses to individual boiler masters in the boiler-drum water-level recorder on each panel. Load division between boilers in response to impulses from the master controller is determined by adjustment of the individual boiler masters.

Fig. 2 (Below)—Isometric view of coal-handling and pulverizing equipment. Fig. 3 (Bottom)—Coal fed from the bunker is automatically proportioned to air flow through the mill by a two-diaphragm operated unit



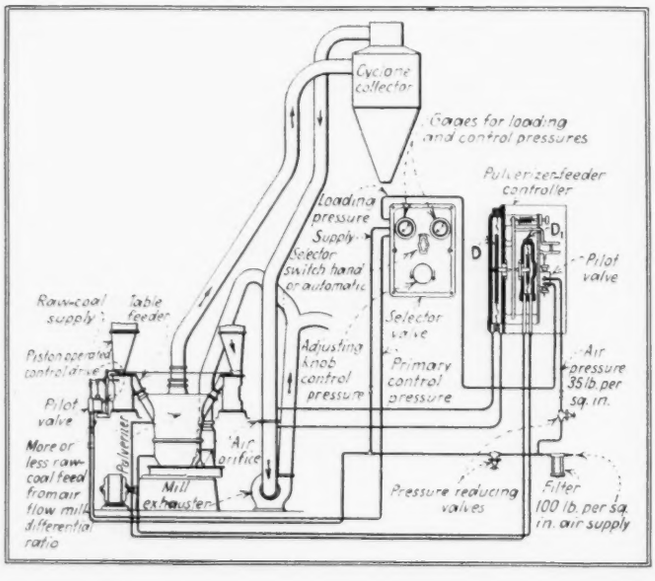
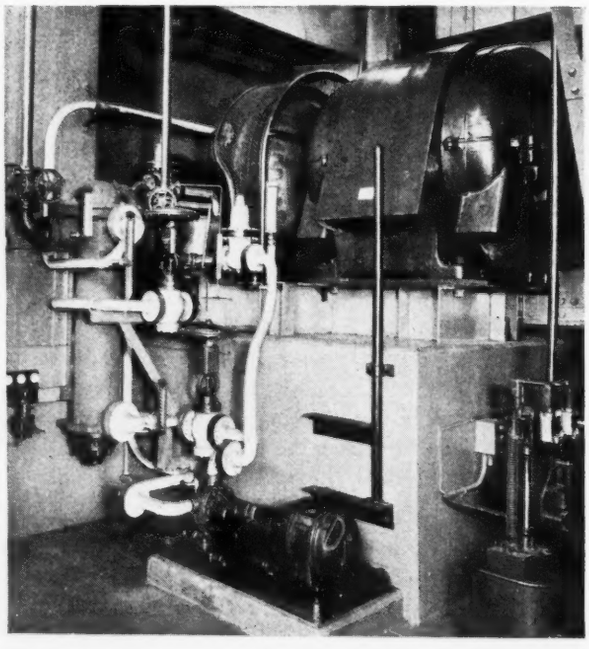


Fig. 4—Each induced-draft fan is driven by a 700-hp. squirrel-cage motor through a variable-speed hydraulic coupling



Loading pressure is applied to the pulverized-fuel feeder control drive through a safety relay. If an induced-draft fan stops, this relay reduces the loading pressure to one-half normal, thus maintaining the parallel relation of fuel and combustion air with single-fan operation. The eight feeder motors have their speed controlled by a piston-operated drive similar to that used with pulverizing-mill feeder control. This drive operates a rheostat to vary the voltage on the feeder motors through a variable-voltage system.

An emergency fuel-control drive, arranged to operate the field rheostat of a spare motor-generator set may be electrically connected to the variable-voltage system of either boiler, through a transfer selector valve. If control air pressure drops below 25 lb. per sq.in., a bellows-operated bypass valve on the fuel-control drive bypasses the cylinder to prevent further motion of the drive, thereby maintaining constant feeder speed.

Loading pressure to the induced-draft-fan control is supplied through a differential relay controlled by loading pressures from the master steam-pressure recorder-controller pilot valve and the steam-flow, air-flow pilot valve on the boiler meter. Variation in either factor changes the speed of the induced-draft fan. A small air compressor driven from the variable-speed shaft of each induced-draft fan produces an air pressure proportional to fan speed. This pressure is balanced against the air-loading impulses established by steam pressure and the steam-flow, air-flow relation. It is the resultant of these pressures that determines the control pressure transmitted to the hydraulic-coupling oil-pumping system of the fan.

The resultant loading pressure, determined from steam pressure and steam-flow, air-flow relation, is also transmitted to the forced-draft fan controls in combination with the loading pressure established by a furnace-draft controller. The forced-draft fan speed, therefore, responds to a change in any of these three factors. An air compressor driven from each fan shaft, similar to those used on the induced-draft fan, transmits loading pressure which is balanced against the other three loading pressures to give the actual fan-speed control pressure.

During operation the forced- and induced-draft dampers are wide-open. These dampers may be opened or closed when starting or shutting down the boiler by piston-operated control drives, actuated by remote manual selector valves on the boiler-control panels.

Provision is also made for automatically closing the dampers of any fan which fails. This is done by solenoid-operated valves connected to the fan-motor oil-circuit-breaker auxiliary contacts. These valves cut off damper-control-drive loading pressure when the fan motor fails, thereby closing the damper. Failure of both forced-draft or both induced-draft fans will cause the dampers of both fans to open automatically to their maximum position.

The forced- and induced-draft damper-control drives have a bellows operated bypass and an air-failure lock. These fix the control drive and dampers in place on air-pressure failure, preventing movement of the dampers under these conditions. Forced- and induced-draft fan speeds will increase on failure of air pressure.

The control systems were designed to combine maximum economy with simplicity of operation and to eliminate possible operating hazards. Several months' operating experience seems to indicate these expectations will be realized.

Fig. 6—Cross-section of a hydraulic coupling and its control equipment and connections

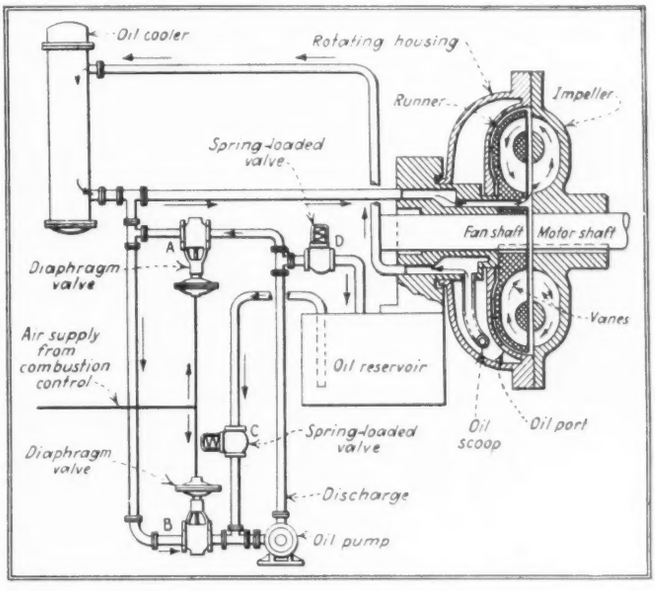
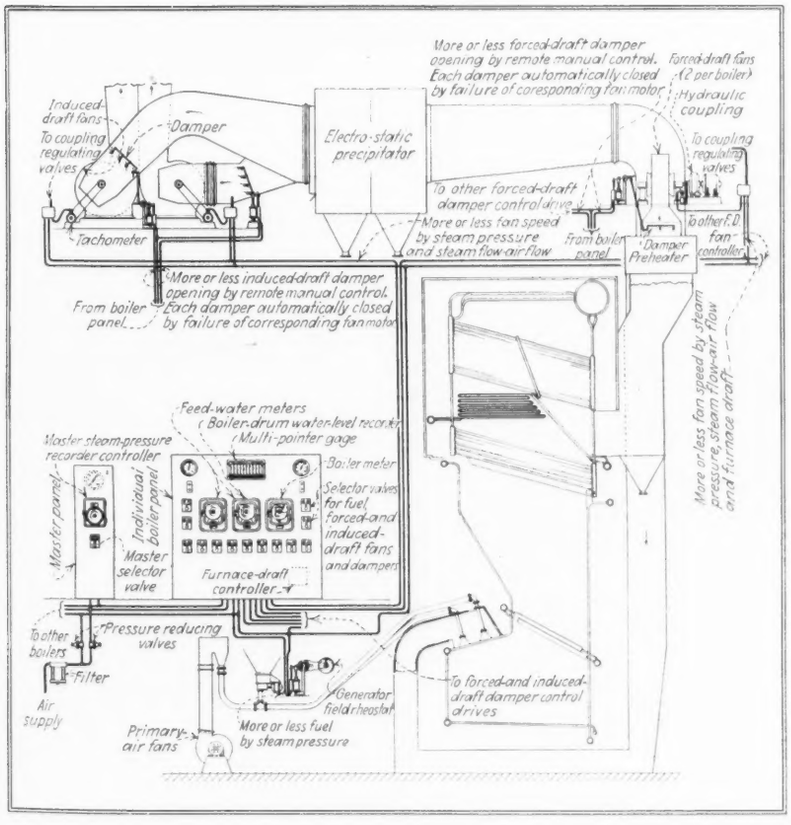


Fig. 5—Diagrammatic layout of the automatic combustion-control system for one boiler


More or less forced-draft damper opening by remote manual control. Each damper automatically closed by failure of coresponding fan motor
Forced-draft fans (2 per boiler)
Hydraulic coupling
Induced-draft fans
To coupling regulating valves
Damper
Electro-static precipitator
To coupling regulating valves
To other forced-draft damper control drive
To other F.D. fan controller
More or less fan speed by steam pressure and steam flow-air flow
From boiler panel
Damper Preheater
Tachometer
More or less induced-draft damper opening by remote manual control. Each damper automatically closed by failure of corresponding fan motor
From boiler panel
Feed-water meters
Boiler-drum water-level recorder
Multi-pointer gage
Master steam-pressure recorder controller
Boiler meter
Selector valves for fuel, forced- and induced-draft fans and dampers
Master panel
Individual boiler panel
Master selector valve
Furnace-draft controller
More or less fan speed by steam pressure, steam flow-air flow and furnace draft
To other boilers
Pressure reducing valves
Filter
Air supply
Generator field rheostat
To forced and induced-draft damper control drives
Primary air fans
More or less fuel by steam pressure

Namm Store
SAVES WITH DIESEL ENGINES

By Huxley Madeheim and Henry Rosenthal
Consulting Engineers

SINCE April the Namm store, one of the large department stores of Brooklyn, N. Y., has been supplied with electric power from its own diesel generating plant of 900 kw. capacity, and air conditioning is now nearly ready for the store's basement, first floor and second floor dressing rooms. The total cost of the diesel plant and air-conditioning is $275,000, of which about $170,000 was spent for the diesel plant and electrical changes necessary. Present indications and estimates of maintenance made by the store's engineers indicate that the diesel plant will pay for itself out of savings over previous costs for central station service in 6 years. Based on the consumption of 2,240,000 kw.-hr. per year, operating costs are estimated at 0.8 cents per kw.-hr.

An unusually complete survey of the electrical, heating and hot water loads was made by the engineers for the store, on which to base plant studies. Half-hourly load readings were obtained for an entire year and from these maximum, minimum and typical load curves were prepared for each month for week days, Sundays and holidays and the Christmas season separately.

Boilers Not Fit

The boilers installed for heating the store were designed for 200 lb. pressure but were 15 years old. Investigation disclosed them not to be in good condition. To use them at their design pressure for supplying steam to engines for power generation would have required new feed piping and pump and to submit them to hydraulic test which it was felt they might not stand. In addition it was found that the store had a relatively low heat consumption for winter heating and that the exhaust of only one 200 kw. engine would be sufficient for the heating system. The reasons for the low steam consumption for heating is the large population in the store and the large lighting load. Thus these studies indicated a diesel plant to be the most economical type of power plant, particularly with the provisions made for utilizing waste heat from the engines.

The load survey indicated that except for the Christmas season the maximum load would be 700 kw. and the summer maximum would be 570 kw. without air conditioning. To provide for reliable operation it was assumed that the largest operating unit may fail at the moment of maximum load which resulted in the installation of four 200-kw. units and one 100-kw. unit with space available for an additional 100-kw. machine.

All five engines are 6-cyl., 4 cycle solid-injection Worthington diesels. The larger units are 300 hp. with $10\frac{3}{4}$ in. bore and $14\frac{1}{2}$ in. stroke, direct connected to 200 kw. Crocker Wheeler generators driven at 400 r.p.m. The smaller unit is 150 hp. with 8 in. bore $10\frac{1}{2}$ in. stroke operating at 514 r.p.m. All have Bosch injection pumps. The larger engines are equipped with Woodward governors but the smaller engine has a Pickering governor. Should oil or water temperature become excessive or should oil or water pressure fail an alarm system operates. Each cylinder is provided with a pyrometer which indicates at a central point the temperature of the exhaust gas of that cylinder.

Spring Foundations

Engines are all supported on spring foundations to prevent vibration being transmitted to the building. Each foundation consists of two 2-ft. thick reinforced concrete slabs. One slab rests directly on the ground, the other is supported on springs which bear on the first slab and hold the second slab $\frac{1}{8}$ in. above it. The springs are in C.I. boxes bolted to channel beams that extend lengthwise on each side of the engine. Concrete of the top slab was poured around the beams and spring boxes. Each box contains four helical compression springs. For the 200-kw. units 5 spring boxes are bolted to each channel making 10 sets of springs for each engine. The springs are removable and adjustable from the engine-room floor and were designed and furnished by the Korfund Co.

Fuel oil is stored in a 13,000 gal. rectangular tank divided into two compartments and housed in a brick room with space around it as required by the New York Building Code. Each of the large engines has its own 98 gal. day tank; that for the small engine has 64 gal. capacity. One hand and two electric pumps are provided for pumping oil from the storage tank to the day tanks. Oil to each day tank is metered separately, and individual tank level gages are provided at the valves controlling flow of fuel.

Clean lubricating oil is stored in an overhead tank of about 2 bbl. capacity and piped to each engine crankcase. Each crankcase can be drained to a floor sump of about 2 bbl. capacity from which a centrifuge delivers clean oil to the clean oil tank.

Fresh air for both the engine room and for air conditioning is taken from a shaft extending to the store roof thus insuring an air supply free from dust and automobile fumes. A 15,000 c.f.m. fan supplies air to the engine room through an Independent automatic self-cleaning filter. About 10,000 c.f.m. of this air is cooled by well water and used to ventilate the engine room. The remaining, 5,000 c.f.m., is taken through ducts under the engine room floor. Individual connections from each engine intake manifold are connected to the

under-floor ducts and supply the engine with air for combustion. An emergency filter and damper just outside the engine room makes it possible for the engine to take air from the basement in case of fan failure.

Engine exhausts are carried separately for about 100 ft. and are then connected to a 30-in. manifold which joins a 30-in. spring supported steel stack in a brick chamber. Space between the brick chamber and the stack is used to exhaust air from the engine room. The top of the stack has a Maxim silencer. In addition each separate exhaust from three of the engines has a Maxim silencer. The other two engines have heat exchangers in the exhaust and no silencer.

Cooling water for the engines is normally provided by a closed system supplied with city makeup water, thus avoiding trouble from scale in the engine. In case of emergency, however, cooling water can be supplied direct from the city mains or from the building roof tanks thus giving three sources of cooling water supply.

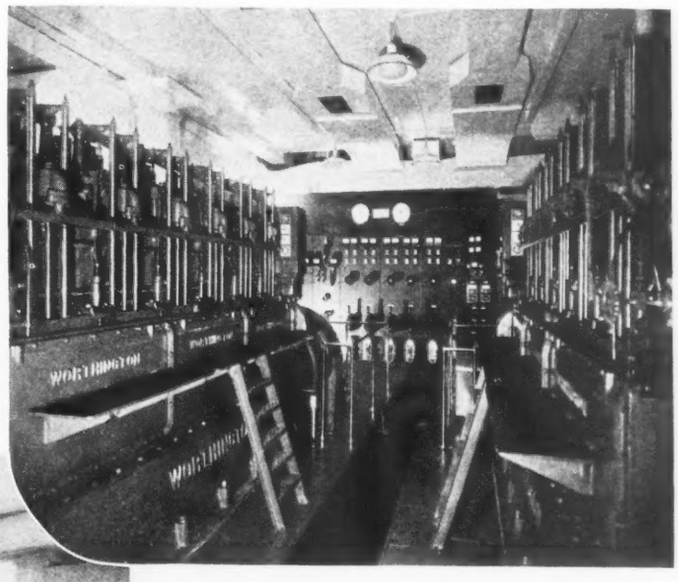
The closed system consists of a 600-gal. surge tank from which two 300-g.p.m. circulating pumps (one a spare) supply water through a Griscom Russel shell and tube heat exchanger to a loop header. Each engine is connected to this header through flexible joints and individual electric driven pumps circulate cooling water through the engine. The quantity of cool water taken by each engine is controlled by a thermostatic valve in the water discharge line regulating the temperature of the discharge water to 130 deg. The heated water returns to the surge tank. The cooling water system is shown in the diagram.

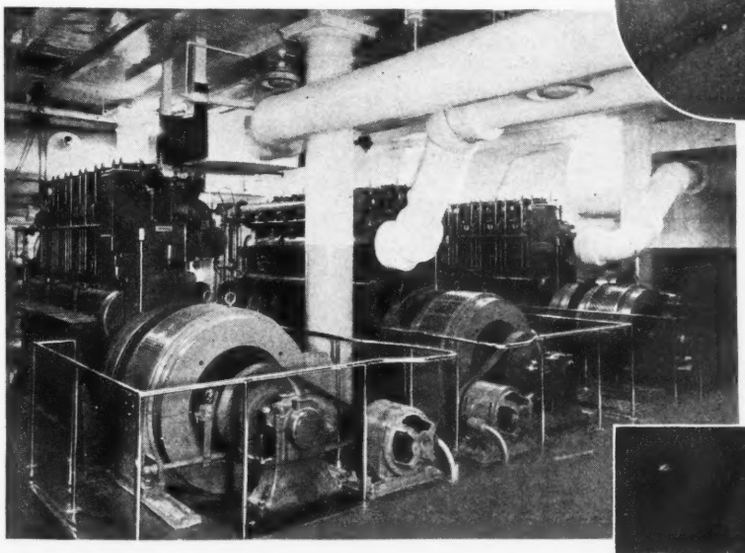
The closed system is cooled by about 63-deg. water obtained from a gravel well 100 ft. deep, with an outer 30-in. casing and an inner 12-in. casing, and having sufficient capacity to deliver 600 g.p.m. During the winter one well pump has sufficient head to deliver 250 g.p.m. to the tubes of the heat exchanger which is designed to reduce the diesel cooling water from 120 deg. to 90 deg. allowing a 30 deg. rise in the engine. During the Summer a second pump operates in series with the first and together deliver 600 g.p.m. half of which is used for air conditioning and half for engine cooling. That portion used by the engines first passes through Aerofin coils which cool the air used to ventilate the engine room. The water used for air conditioning partly cools the fresh air and then passes to the condenser of the refrigerating machine.

The New York Water Conservation Board requires that ground water pumped from Long Island must be returned. Consequently a large diffusing well had to be provided to dispose of the well water pumped for cooling purposes.

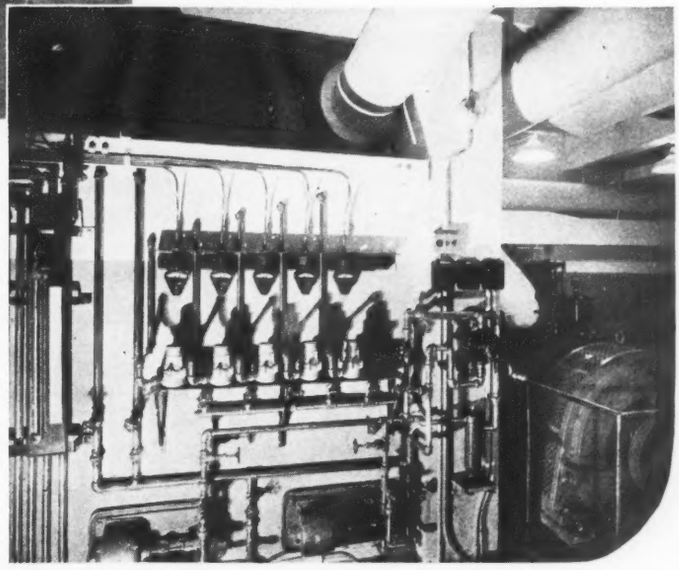
During the winter hot diesel circulating water is used in the chilled water coils and provides sufficient heat for the basement and first floor with all steam radiation shut off. It is expected that the water will return cool enough to use in the engine without cooling by well water.

All of the hot water requirements of the store are provided by the heat exchangers in the exhaust lines of





Above—Looking between two of the 200-kw. diesels at the switch board. Left—One of the water heaters can be seen in the exhaust from the 200-kw. engine at the left. Below—Pumps at the bottom of the picture supply fuel oil through individual meters to each engine day tank. Directly above each meter are the day-tank level gages. At the right is the 100-kw. diesel



the two 200 kw. engines. A 20 g.p.m. pump takes water from the surge tank of the engine cooling system and delivers it through either of the heat exchangers to either the existing hot water heater or a new roof tank. The pump is under pressure control to shut down when the roof tank becomes full. A thermal syphon between the roof tank and the heaters provides circulation through the heaters when the pump is not operating. All water piping both in the engine room and for air conditioning is red brass.

As generation is 60 cycle at 208 volts, two 50-kw. motor generator sets were installed to provide d.c. which is used by all but two service elevators. Since this load is extremely fluctuating a high slip motor with a 1½-ton flywheel is used to drive each generator to prevent d.c. load fluctuation from affecting the a.c. system. When these sets operate in parallel the series field of one d.c. generator is in series with the armature of the other to insure equal load division.

A new type Ward Leonard voltage regulator is used for each generator. It employs electron tubes which rectify current from the a.c. bus supplying d.c. to the field of the exciter. Principal regulation is obtained by changing filament current and not through grid control. Automatic relays cut in self-excited fields on the exciter in case of tube failure and during starting up of an engine set. Frequency control is obtained by a two clock system one of which is operated by connection to the central station system, for this purpose only.

A combination central and unit air conditioning system has been installed to take care of the basement, street floor and dressing rooms on the second floor. All fresh air is filtered, cooled in Summer and heated in Winter at a central point. All recirculated air is cooled and delivered by unit conditioners made by Cooling and Air Conditioning Corp., and installed by Carbondale New York Co.

Fresh air taken in from the previously mentioned shaft is handled by a two speed fan having capacity to deliver 27,000 c.f.m. at low speed and 35,000 c.f.m. at high speed. This amount of fresh air allows 10 cu.ft. per person based on actual population counts. The fresh air is filtered by automatic self-cleaning filters and then passes through two sets of fin type cooling coils. The first coils receive 63-deg. water from the well which provides about 100 tons of refrigeration. The second coils are supplied with chilled water when necessary from a 175-ton Freon compression refrigeration system. These chilled water coils receive diesel engine circulating water in the Winter for heating.

Exhaust fans are not provided for the first floor. The supply fan therefore causes a pressure in this area and air leaks out through doorways that are on all four sides of the store. Exhaust fans are provided to remove vitiated air from the basement. They have a somewhat greater capacity than the supply and therefore draw air down from the first floor, thus preventing cafeteria and shoe department odors from reaching the first floor, a condition that had been annoying. Individual exhaust fans ventilate the basement shoe shop, cafeteria, butcher shop, dressing rooms and shipping department.

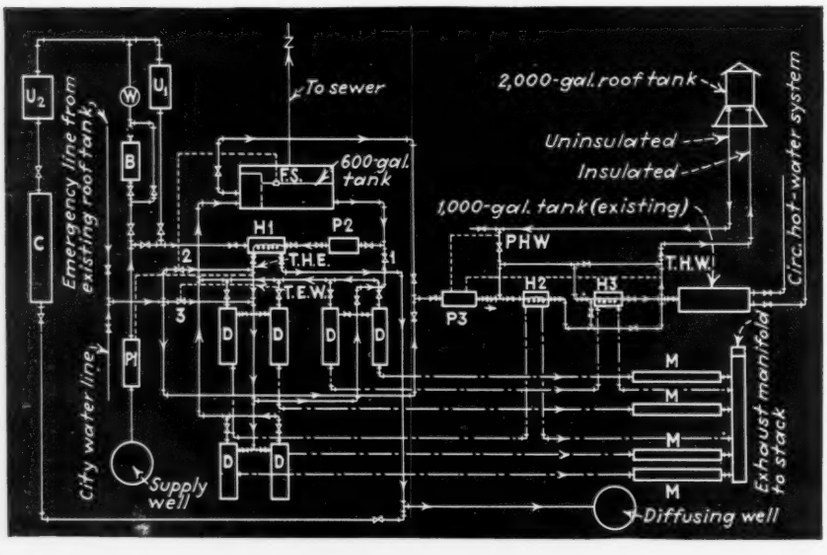
The conditioning units vary in size from 1,500 to 10,000 c.f.m. They receive chilled water from the refrigeration system and cool recirculated air. Two units are used in the basement, 6 units on the main floor and 1 unit on the second floor. Some of the units are floor mounted and some are hung or supported above the floor, depending upon local conditions. They have been placed around the periphery of the store space and in enclosed departments. The total recirculation provided by these units amounts to 100,000 c.f.m.

4-Point Compressor Control

Refrigeration is provided by a 2-cyl., double-acting 175-ton Freon compressor driven by one of the 200-kw. diesels through a Fast coupling arranged so the compressor can be disconnected from the engine when it is not required. This arrangement eliminates motor inefficiency particularly at low loads. Control of compressor capacity to meet air conditioning load is by compressor bypassing, giving a 4 point control. Compressor, shell and tube condenser water cooler and pumps were furnished by Worthington.

A master thermostat in the fresh air inlet resets local thermostats to give a 15 deg. differential when the outside temperature is 95 deg. and a 0 differential when the outside temperature is 72 deg. Thermostats on the unit conditioners operate bypass dampers. As more air is bypassed the chilled water returns at a lower temperature and so operates a thermostat controlling compressor bypasses.

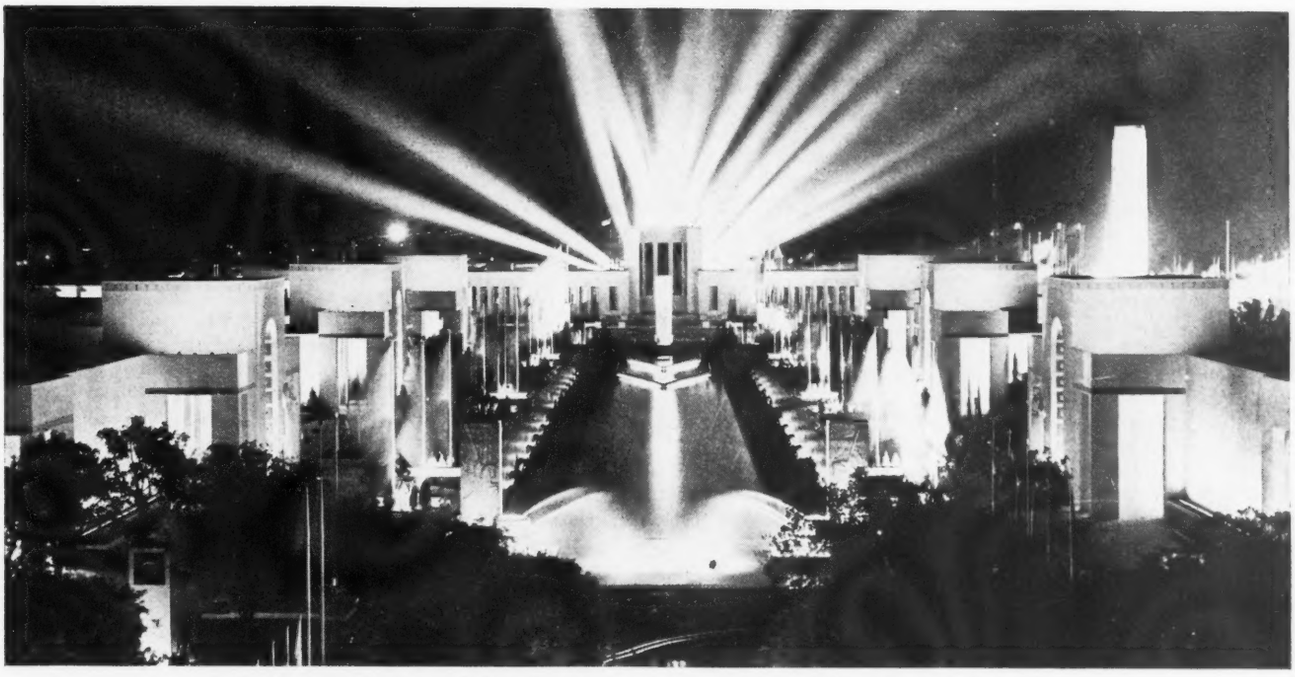
The air conditioning system is designed to maintain 80 deg. and 50% relative humidity when the outside dry bulb is 95 deg. and wet bulb 75 deg.



Schematic diagram of water system for engine cooling and air conditioning

LEGEND

H1—Diesel water cooler P1—Well pump
P3—Hot water pump M—Maxim silencers
H2, H3—Exhaust heaters
P2—Diesel water circ. pump
F.S.—Float switch operating valve No. 2 —D Diesel engines W—Water meter
No. 1—Pressure-controlled Valve Shutting Off Engine System From 600-gal. Tank
No. 2—1½-in. solenoid valve admitting makeup water
No. 3—2½-in. valve admitting emergency city water
T.H.E.—Temp. control on well pump
T.E.W.—Temp. control on valve No. 3
T.H.W.—Temp. control on hot water pump (P3) to cut out pump below 120 deg. F.
P.H.W.—Pressure control on hot water pump
B—Booster pump C—Freon condenser
U1—Eng. room cooling unit
U2—Fresh air cooling unit



Looking toward the Texas Hall of State from the main entrance of the Texas Centennial Exposition

MECHANICAL ENGINEERS MEET IN LONE STAR STATE

TWENTY technical sessions and 45 papers featured the Semi-annual Meeting of the American Society of Mechanical Engineers in Dallas, Texas, June 15-20, attended by 300 engineers from all over the country. Included were several sessions on power and power processes and many related papers.

I. F. Bingham, University of Oklahoma, in "Cementing Hot Oil Wells," gave these figures: Oil wells last year produced 993,000,000 barrels of crude; domestic demand was 973,000,000; total demand, 1,103,000,000. Known reserves are about 12,000,000,000 barrels—a 12-yr. supply. While there is no reason for alarm over an early oil shortage, new reserves must be discovered continually, a search which already requires wells 7,000 to 10,000 ft. deep.

The Calvin W. Rice Memorial Lecture, by Hilding Tornebohm of Gateborg, Sweden, was on "Modern Tolerance Requirements and Their Scientific Determination."

The first Power session, held June 17, with W. A. Shoudy as chairman, heard M. J. Hanlon's paper, "Cracked Residue Fuel Oils" read by H. M. Robinson, engineer, City of Dallas. Largely a discussion of fuel-oil specifications adaptable to power needs it shows the source of residue fuel oils in modern cracking processes. It compares old and new U. S. Navy specifications and shows these advantages for cracked residues: low viscosity for high specific gravity, low pour point and low steam requirements for preheating. In fact, care must be taken in preheating, for overheating tends to precipitate flocculent carbon which clogs burners and piping.

In the discussion F. H. Eberle, Standard Oil of N. J., said the paper was largely a duplication of one presented in April, 1935, and the author's differentiation between cracked residues and Bunker C is of doubtful value, since, with many refiners, the terms are now synonymous.

Glenn C. Boyer of Burns & McDonnell Engrg. Co. discussed his method of "Analyzing Variable Load for Diesel and Steam Stations," which appeared originally in *Power* on page 370, July, 1935. He explained that his object is to bring the subject out for discussion to improve this simple and ingenious method. His studies have shown that peak and minimum loads may bear the relationship of 4 or 6 to 1, normally with no relationship to load factor. He feels that present errors of 7.5 to 10% with his method can be reduced with better understanding of the principles.

H. E. Chambers, Jr., Dallas manager for A. M. Lockett Engrg. Co., said he had used the method recently to obtain comparative fuel costs for oil and gas engines and found it simple and flexible. It was also suggested that the method might be used in setting up operating "bogeys," the difficulty being variation in operating skill. In steam-turbine problems, seasonal-load-variation curves must be worked out as separate problems. In diesel studies, accurate results require that allowances be made for altitude, age of engines, summer water conditions, etc.

Thomas E. Crossan and A. J. Matherne, Jr., of Louisiana Steam Generating Corp., presented "Operating experiences with Automatic Combustion Control When Burning Gas, Fuel Oil, Acid Sludges and Petroleum Coke." Their Baton Rouge plant furnishes steam and electricity to a large oil refinery and chemical plant, steam demand averaging 800,000 lb. per hr. and electrical demand 16,000 kw. Equipment includes 5 cross-drum, straight-tube, 350,000-lb. per hr., 620-lb., 725-deg. boilers and three 15,000-kw. non-condensing turbo-generators exhausting to process at 135 lb. Major auxiliaries are turbine driven.

Natural gas makes up about 70% of the fuel, the rest being petroleum-coke breeze and sludge. Each boiler has a 6-pt. draft gage, steam-flow air-flow meter, CO_2 and CO recorders, 6-pt. temperature recorder, and usual steam and water-pressure gages and thermometers.

The combustion control system maintains constant pressure in the main steam header, continuously regulating fuel and air supplied to maintain highest practical efficiency. It also regulates the proportion of fuels to maintain uniform heat input to the furnace for any one rate of combustion. The automatic control operates on the gas only, supplies of the various fuels being balanced so that there is always enough gas for regulation.

All five boilers can burn natural gas and fuel oil, four can burn acid sludges, two can also burn petroleum-coke breeze. Nor-

mally, coke breeze and gas are burned under two boilers, sludge and natural gas under two others, and the fifth operates on natural gas. Fuel oil is for standby only—burned under manual control when gas supply fails.

Gas forms 40 to 90% of the fuel burned under any boiler, 40 being the minimum that gives proper control. The fuel corrector in the control system adjusts the ratio of natural gas to *total air* to compensate for quality and quantity of other fuels not under the combustion-control system.

CO and CO_2 records and flue-gas analysis are used to keep the regulation rate and to build up a background of operating experience so that CO_2 may be predicted with given fuel mixtures. Best combustion efficiency requires the following excess air with the given fuel mixture: Natural gas—10%, 90% gas and 10% coke—25%, 80-60% gas and 20-40% sludge—18.25%, 80-60% gas and 20-40% oil—15-20%.

Flow Measurements

In a simultaneous session, "Automatic Regulators, Their Theory and Application," by Ed. S. Smith, Jr., of Builders Iron Foundry, "A New Flow-Control Element Using Two Orifices in Series," by M. C. Stuart of Lehigh University and D. R. Yarnall of Yarnall-Waring Co., and "Fluid Meters Research," by H. V. Beck, University of Oklahoma, were presented. The Stuart-Yarnall paper shows how, for steam and hot water, "between-orifice" pressure rises rapidly under certain conditions, a principle recently used in a new type of steam trap. Discussion brought out that this trap was another of the many engineering advances made by intuition and later proved by analysis, which would seem to indicate that analysts need more imagination—to see these things before they happen instead of afterward.

At the second Power session, Thursday morning, Robert R. Crowdus of Dallas Power & Light Co., explained "Chlorination of Circulating Water and Algae Control." Dallas steam-electric station, with the country's largest spray pond, uses chlorine gas to eliminate scale-causing algae. This 82,500-kw. station has a 10,000,000-gal. spray pond covering 8⅔ acres with a maximum circulating and spraying capacity of 140,000 g.p.m. through 2,550 nozzles. Pond walls are concrete, the bottom dirt. Normal recent operation has been 80,000 g.p.m.

The trouble was hard scale, requiring 100 man-hr. a month to remove, and originally thought to be caused by precipitation of scale-forming materials from the water, which is saturated with calcium and magnesium carbonate. But analysis showed the scale was 40% organic.

It was found that algae was attaching itself to the tube walls, collecting inorganic matter and forming slime. The algae soon died, and the slime became a hard scale. At the bottom of the pond, this process formed large sheets which came loose upon sudden changes of temperature and clogged intake screens. Some of the algea came from "seed algae" pumped out of the wells with the 20 to 30 million gal. of makeup each month, the rest apparently from the air. Sand filters did not remove it and the copper sulphate that had been used to inhibit algae growth (hung in sacks in front of the intake) did not entirely prevent it even when sprinkled around the pond, because the high sodium content of the water precipitated it as a white powder.

In 1931, scale was forming in the condensers faster than it could be removed, and a $12,000 revolving screen seemed necessary. Instead, chlorination was tried. Laboratory tests of even only 0.2 p.p.m. showed algae destruction, but apparatus was expensive and no attempt had been made to use the process in spray ponds. Cheapest arrangements cost $5,000, rather expensive for an experiment. Although dangerous, the gas could be controlled easily, was readily detectable by odor and color. But ordinary needle valves would not control it, and if bubbled into the water, it either escaped or got into the condensers, causing corrosion that was worse than the scale.

The solution was injection of the gas into primary water with air injectors (see Fig. 2) then conveyance of the mixture to the spray-pump suction through high-grade air hose. A gummy substance in the chlorine tanks caused some sticking of valves, but serious trouble was avoided by buying the gas which contained least gum.

Experiments proved so satisfactory that the complete installation was made. It effectively killed all algae growth in the pond, prevented formation of slime and scale on tubes, reduced nozzle scale formation 80%, eliminated valve-seat and settling-tank deposits. Elimination of condenser-tube deposits decreased terminal temperature difference 3 deg. F., saving $4,000 per yr., and reduction of cleaning labor saved another $3,000. Cost of the chlorine to do this is about 1.5 cents per million gal. of water circulated or about $1,000 a yr.

Continuous injection is used rather than periodic, because it requires less gas and kills seed algae as fast as it enters the pond. Chlorine is fed so as to maintain a residual of 0.1 p.p.m. at the condenser and 0.05 p.p.m. in the pond. Water has lost its greenish color and the algae has disappeared, so now only 50 lb. of chlorine need be fed a day, except in the three summer months, when it is increased to 70.

"Heat Balance vs. Water-Weighed Boiler Tests" was presented by E. L. McDonald of Kansas City Power & Light Co. His company had large boilers and considerable difficulty in diverting large quantities of water, so considered the heat-balance method. His conclusions are that this method is entirely satisfactory as an operating check, and that principal errors are introduced by personnel, not by method. Heat-balance methods include the greater *number* of errors, but their cumulative effect is no greater. Even with decided errors in coal analysis, the final error need be only 1%.

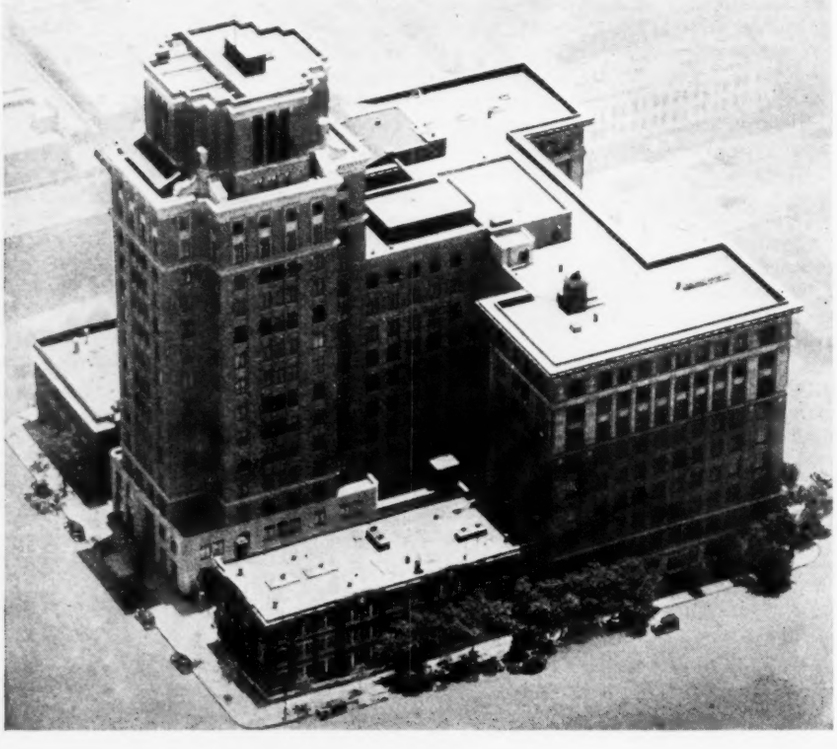
On Friday morning, Norman G. Hardy, superintendent of power, Texas Power & Light Co., discussed "Operating Experience with Pulverized Texas Lignite in a Large Central Station," the station in question being Trinidad, his company's 75,000-kw. base-load station 65 mi. southeast of Dallas. First large station to burn Texas lignite, Trinidad was also the first to pulverize it, and after ten years of operation, has used pulverized lignite entirely, although the only station burning it this way.

Fuels Session

Trinidad is noteworthy for its very simple design. Its steam-generating units have no air preheaters, economizers or induced-draft fans, increasing reliability and reducing maintenance costs. Fuel ranks between peat and bituminous, being a dull-black, high-moisture fuel showing the grain of the wood from which it was formed, but differing from German brown coal in that it includes no unconverted woody material. It is brought from mines about 8 mi. away.

Storage capacity is small and simple (capacity to reclaim is 58 tons per hr.) because it is preferred to burn the fuel at once. To be stored, it must be leveled off 2 ft. deep, then rolled to exclude as much air as pos-

Fig. 1—Humble Oil Co. 9-story office building in Houston, Texas, air-conditioned to 80 deg. dry bulb and 50% R.H. when outside temperature is 100 deg. dry bulb and 79 deg. wet bulb.



sible, then built up in 2-ft. layers to 8 ft. Only twice has this reserve been used, once due to a railroad wreck, once due to a flood, and several spontaneous fires occurred before proper storage methods were developed.

The station contains four 185,000-lb. per hr., 3-pass., cross-drum B&W boilers with interdeck superheaters and two 20,000-kw. turbines installed in 1926, and two 325,000-lb. per hr. single-pass B&W boilers with interdeck superheaters and a 35,000-kw. turbine installed in 1931. Steam pressure is 425 lb. per sq.in. on the old boilers, 450 on the new, with temperature in each case 750 deg. F. Old boilers are fired with 12 Lopulco burners each, and have one screw-type feeder per burner. The newer boilers, one shown in cross-section in Fig. 3, are fitted through 14 Lopulco burners with one feeder for each pair. Feeder speed on all boilers is controlled from the firing floor. Auxiliaries are all electric driven.

Operation on all boilers has been highly successful, performance being very close to that predicted and no major repairs or alterations being required. No difficulty has been encountered with ignition or in maintaining fires, and simple asbestos torches impregnated with kerosene are used for lighting up. Over-all boiler efficiencies for the station were 77.2% in 1933, 76.2 in 1934 and 1935.

"Operating Experiences with the 1,450-lb. Deep-Water Steam and Electric Station," by H. G. Hiebeler, assistant superintendent of power, Houston Lighting & Power Co., was a progress report on this station. After trial operation began in February, 1932, it was found necessary to add superheater elements to raise final temperature, etc.

In 1935, this station had an output of over a hundred million kw.-hr., of which more than 88% was generated by reheated steam. Lack of load has limited possible operating savings. The high-pressure unit provides reheated steam to the old plant, steam coming from the boiler at 1,325 lb. and 850 deg., going through a thoroughfare reheater where it drops to 720 deg. then to the high-pressure 12,000-15,000 (maximum) —kw. turbine. It comes out of the turbine at 360 lb. and 460-470 deg., passes through a condensing reheater which it leaves at 570 deg., then through the other side of the thoroughfare reheater, which it leaves at 750 deg., passing to the older low-pressure turbines.

Loading Turbine

It is most economical to load the high-pressure turbine to 15,000 kw. as much as possible, because it generates a kilowatt-hour with only 4,500 B.t.u., as compared with 15,000 B.t.u. in the old plant. At 15,000-kw. loading the high-pressure turbine passes about 600,000 lb. of steam per hr., which for complete utilization requires 67,500-kw. load. The minimum, however, is only half that, so the plant could carry maximum loading only 1,400 hr. in 1934 and 3,700 hr. in 1935. The more than doubled period of maximum loading in 1935 was created by an average load increase of only 9,000 kw.

Outage due to plant and turbine causes in 1933 was 613 hr.; in 1934 it was 964 hr., outage due to the turbine being 208 and 450, respectively. This gives a turbine availability of 97% for 1934, while the actual operating time was 93%. Hours of reduced capacity were 2,200 in 1933, 1,362 in 1934 and 1,337 in 1935.

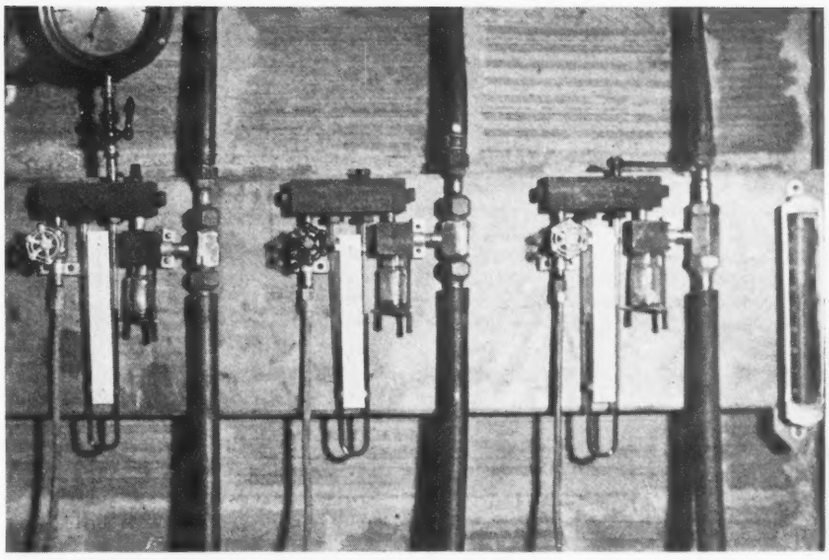


Fig. 2—Three air injectors feed 50 to 70 lb. of chlorine per day into primary water for Dallas (Texas) Power & Light Co. to control algae

The major factor in boiler outage has been economizer leakage, also a little superheater leakage. 1935 operation, however, showed most of these difficulties ironed out. One-third of the outages thus far have been for general inspection and cleaning, mainly in 1933 and 1934, when the boiler was inspected every three months, twice as often as now. A quarter of the outages were due to economizer leakage. Tubes were lost only once, early in plant operation, due to faulty water treatment.

In operation, it is vital to watch water conditions closely to avoid turbine deposits. The water completes the circuit from boiler through turbine and back about six times an hour, so a little leakage causes much contamination and silica deposits in the low pressure turbines which are so hard they must be chipped off. Otherwise the high temperature and pressure have caused no real trouble.

"Availability of Natural Gas Fuel for Central Stations" was presented by Elmer F. Schmidt, general superintendent of Lone Star Gas Co., Dallas. Mr. Schmidt pointed out that natural gas is fuel in refined form, and storage space and equipment, fuel- and ash-handling equipment must be considered in comparing it with other fuels. Most Midwestern industrial centers now have gas, and in this region 78% of the power generated by central stations is with gas, 16% with coal and lignite, and 6% with oil. It is necessary for gas-fired stations to have standby fuel-burning equipment (usually oil) in case gas supply fails.

Gas companies themselves want central-station load because load factor is high and not subject to great fluctuations, either temporary or seasonal. About 28% of gas pipeline sales are now to central stations, most contracts being long-term and permitting temporary diversion of gas supply if absolutely necessary.

Diesel Sessions

At the first Diesel Session, N. Fodor of Allis-Chalmers Mfg. Co., described a "Fuel-Injection, Spark-Ignition, Oil Engine" which his company is making for tractor and power-unit use. As compared with the gasoline engine torque-variation ratio of 2, that for the diesel is 4.6 hence requires much stronger parts. Allis-Chalmers, however, wanted an engine that would operate on cheap fuels but still incorporate a design as similar as possible to the company's gasoline engines, so both could be built on the same production line. The new design has a compression ratio of 16-1. Average force peaks are only one-third as great as those of the diesel.

Cylinder block, crank, connecting rods and other parts are like those of the company's gas engine, and the unit has the cup-shaped piston head, flat-top cylinder head, side injection and opposite-side firing of the Hesselman. Fuel pump and injectors are like those of a diesel. Spray nozzles are multi-orifice units to give turbulence and mix in the center core of rich mixture before firing. A 12-volt battery provides starting and ignition; spark must be hotter than that of a gasoline engine. Fuel injection begins at 50 deg. before top dead center; ignition occurs at 12 deg. before. With all auxiliaries, the engine is claimed to attain a full-load fuel economy of 0.5 lb. per b.hp.-hr.

It was brought out in discussion that this engine differs from the Hesselman in that it is designed to produce a uniform mixture instead of a group of concentrations, and is started by priming with a shot or two of gasoline into the manifold.

L. E. Hebl and T. B. Rendel of Shell Petroleum Corp., presented a "Comparison Between Fuels for High- and Low-Speed Diesel Engines," which included an analysis of diesel models by speed, showing that the majority have a speed of 1,700 r.p.m., although the highest-speed units now reach 3,000 r.p.m. as compared with 2,300 r.p.m. two years ago. The refiner thus should furnish fuels for 1,700 r.p.m. units. In order that the diesel's higher thermal efficiency be of any advantage, it must operate on cheap fuels as do other prime movers. This may mean cracked residues, with possible high sulphur, carbon and ash. Volatility and viscosity may also vary widely—something which the present high-speed diesel cannot

compensate for. Further, fuel must burn faster than in a slow-speed engine, it must be clean and delay must be a standard, dependable period. If the engine designer has failed to design properly for this, the fuel supplier must provide fuels which ignite quicker—and cost more. Other factors which must be provided are low residual fuel content, low pour point, high ignition quality.

Discussors raised the question of piston speed as possibly a better indication of diesel design trends than r.p.m., but Mr. Hebl pointed out that in fuel work, ignition quality particularly is directly controlled by r.p.m.

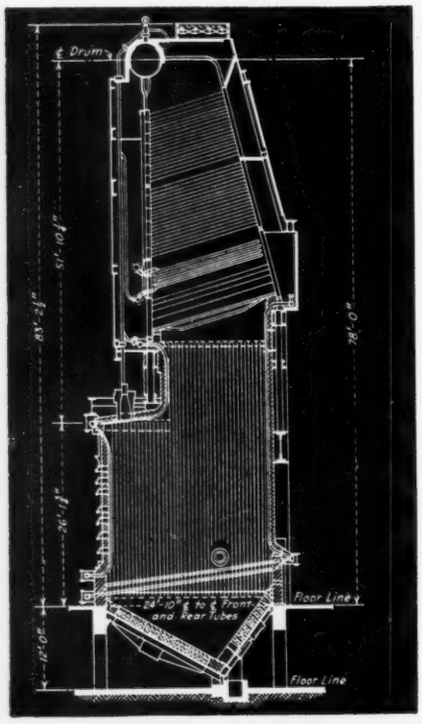
The second diesel session dealt more specifically with oil-country units as previously described in W. C. Lane's articles in *Power*. "Design of Diesel-Electric Oil-Well Drilling Units" by D. M. McCargar and Q. A. Haas of Allis-Chalmers Mfg. Co., "Small High-Speed Gas Engines for Oil-Well Pumping" by J. M. Cooper, Gulf Oil Co., and "Semi-Diesels Mechanically Operated Drilling Rigs" by R. D. Robey, Jr., Olsen Drilling Co.

Air Conditioning

A session on air conditioning was held Thursday morning, with "Air Conditioning in Humble Oil Co. Bldg.," by W. E. Becker, York Ice Machinery Corp., and "Air Conditioning the Robinson Gold Mine" by O. W. Bynum. The latter has been described in *Power*.

Humble Oil Co. has a 9-story office building in Houston, Tex. (Fig. 1), which with its new annex is the largest completely air-conditioned building in the South. Conventional formulas were used in working out the installation, except that a special effort was made to increase air change to compensate for people who smoked. Usually 10 c.f.m. of outside air is required for nonsmokers, 50 for smokers. This design provides an average of 30. Calculations showed 400 tons of refrigeration required to maintain 80 deg. dry bulb with 50 per cent R.H. when outside dry-bulb temperature is 100 deg. and outside wet-bulb 79.

Fig. 3—One of two 325,000 lb. per hr. boilers fired with pulverized Texas lignite at Trinidad station of Texas Power & Light Co.



The building is set at an angle, hence east, west and south required special design for summer; east, west and north for winter. To handle this, a loop system of air distribution was installed for the 2d to 8th floors. Exposure on the roof above the 9th floor required special design there (25% of total conditioning load) so a separate dehumidifier for that floor only was installed in the penthouse above it.

Freon and a compression system were also selected. Two large 203-ton reciprocating compressors, each driven by a 225-hp. synchronous motor at 225 r.p.m., were installed, thus avoiding complications from several small units and providing power factor correction. These are 14x10-in., 4-cyl., single-acting, vertical, inclosed York units, with a 43-in. by 16-ft. long shell-and-tube condenser, a flash-type shell-and-tube water cooler of the same size, and necessary auxiliary receiver and liquid control system.

Average high summer wet-bulb in Houston is 79 deg., so with a 10-deg. range on condenser water it was possible to use 1,200 g.p.m. and maintain low condensing pressure with a forced-draft cooling tower 36x16x20 ft. high having four 5-hp. propeller-type fans and louvre drift eliminators.

Not counting the ninth floor, loads in the east and west wings were equal, so three spray-type dehumidifiers were installed with individual cold-water pumps from the water coolers. Cold-water lines were insulated with cork. Four main supply fans were provided, one for each wing, one for the ninth floor, and one for the separate system for the director's room.

Booster fans pick up cooled air after it passes through a mixing plenum having two connections, one to the supply riser, the other to the return-air grille in the corridor running through the center of each wing. Dampers are provided in each, thermostat-controlled, so that mixing is done on each floor, permitting smaller risers.

In the 17-story tower annex, air conditioning was installed during building. Machinery included two interconnected water-cooling systems. The first is a 15x13½-in., 4-cyl., single-acting York compressor, a 60-in. by 16-ft. shell-and-tube condenser, and a 48½-in. by 16-ft. flash-type water cooler. The second is a 15x13-in., 2-cyl., York compressor, a 43-in. by 16-ft. condenser, and a 33-in. diameter by 16-ft. water cooler. Each compressor is driven by a 257-r.p.m. synchronous motor, the first, 400-hp., the second a 200-hp. Total capacity is about 500 tons.

A water-cooling tower for both buildings, on the second penthouse floor, is 21x53x32 ft. high, totally inclosed and has 2,600 g.p.m. cooling capacity from 95 to 85 deg. F.

The first floor is in two zones, the others in three, with necessary supply and exhaust fans. Floor supplies run in ducts above a hung ceiling and double dampers provide positive control to both floors and rooms. Special controls are provided for executive offices and booster heaters in zone supplies on all floors. Thermostats control these also.

Other power-field papers included "The Spraying of Molten Metal" by L. E. Kunkler, president, Metallizing Co. of America, "X-Ray Testing of Welded Vessels," by H. R. Isenburger, St. John X-Ray Service, "Steam Drilling Equipment," by V. Weaver Smith, vice-president, The Broderick Co., and "Power and Heat Problems in the Sulphur Mining Industry" by C. L. Orr, Texas Gulf Sulphur Co. The first two have been covered in *Power* and the latter two are more or less specialized.

Special Events

After a buffet supper Wednesday, Dr. William Munroe White, chief engineer, Hydraulic Division, Allis-Chalmers Mfg. Co., Milwaukee, lectured on "The Why of Boulder Dam." His talk was divided into two parts, the "why," and the "how." He pointed out that Boulder Dam evolved from three great needs of the surrounding territory: to avoid recurrence of the disastrous Imperial Valley flood of some years ago, the increasing need for water in the Los Angeles district and control of the silt carried away by the river. Power development was undertaken primarily to pay the cost of the dam. More technical phases of his talk have already been extensively discussed in *Power*.

At luncheon each day speakers discussed various engineering subjects. A dinner-dance was held Thursday, a visit to the Centennial Exposition on Saturday.

Texas Exposition

More compact than the Century of Progress in Chicago, but with buildings and lighting effects reminiscent of it, the $8,000,000 Texas Centennial Exposition in Dallas was host for the A.S.M.E. visitors. After lunch at the Exposition, heads of the local sections of the Founder Societies and other dignitaries greeted the guests, followed by Dean A. A. Potter's address "Texas and the Engineer."

Visits included the Ford, General Motors, G. E. and Westinghouse exhibits, Government building (which includes a Tennessee Valley relief map and other elaborate displays), and other buildings, including among other exhibitors Continental Oil Co., DeLaval Separator Co., Lone Star Gas Co., Magnolia Petroleum Co., Pennzoil Co. and Texas Co.

Power at the Centennial is mainly purchased, although there are two isolated plants, both natural-gas-engined, thus far. The larger is in the "Hall of Religions," and includes three 4-cyl., 4-cycle, 6x9-in., vertical, 54-hp. National Transit engines, two directly coupled to alternators (44 kva. —35 kw.) and exciters and the third driving a 4-cyl. 40-ton Carrier Freon compressor for air conditioning. There are also three motor-driven Carrier air-conditioning units. Engines are all being mounted on Korfund vibro-dampers.

The Masonite House has a Waukesha "Ice Engine," a new direct-connected engine compressor unit originally developed for Pullman-car conditioning. A 7-ton capacity unit, it is combined with a silica-gel unit for conditioning. The 4-cyl., 3¼x4-in. 1,160-r.p.m. engine drives a 4-cyl., 3½x2½-in., V-type, 600-r.p.m. Ingersoll-Rand compressor through Gates V-belts with an automatic tightener. High- and low-pressure automatic cutouts are provided, as well as connections for a shell-and-tube or evaporator type condenser. A 1-in. through shaft is available for auxiliary power takeoff. A combination thermostat and humidistat maintains a temperature of 82 deg. F. and a relative humidity of 40%.

C.E.A. CONVENTION PAPERS

MANOR Richelieu, Murray Bay, Quebec, was headquarters for the 46th annual convention of Canadian Electrical Assn., June 24 to 26, 1936. A comprehensive program covering a variety of subjects of interest to the power industry was presented. Of fourteen reports read and discussed at the engineering section meeting, three are of interest to power engineers.

Deterioration and repair of concrete structures have received much attention and study during the last 10 yr. While causes of deterioration have been pretty definitely determined, its prevention and repair are still subject to study and to a certain extent to controversy, as was pointed out in a hydraulic-power sub-committee report, "Deterioration and Repair of Concrete Structure," by J. A. McCrory, chairman.

In general, deterioration of concrete structures can be classified as chemical and mechanical. Chemical deterioration may be caused by dilution of certain constituents of the concrete, such as free lime due to percolation of water through joints and cracks, or by progressive attack on the more stable elements by aggressive water, comparatively high in acid or alkali. Agencies causing mechanical deterioration are, frost, floating ice, logs and falling or turbulent water.

Of the causes resulting in mechanical deterioration, frost and those producing erosion are of greatest moment. The latter are usually due to faulty design, although poor concrete has been responsible in some cases. The most effective means of preventing deterioration in concrete structures, due to both chemical and mechanical actions, is to provide dense, impervious concrete.

Repair of concrete structures frequently offers serious difficulties to the engineer. Various methods have been employed in rebuilding and refacing concrete structures. Filling the defective area with air-deposited cement mortar, such as Gunite, is probably the most successful repair. The committee recommends certain precautions when making these repairs. These are:

1. All disintegrated concrete must be chipped from the face down to sound concrete.
2. Surface must be thoroughly cleaned of all loose material.
3. Old concrete must be thoroughly saturated with water.
4. Work must be done by experienced workmen.
5. Exercise care to properly cure the new face.
6. Where work is done on downstream face of the dam, all water seepage through cracks, joints or porous seams must be stopped.

No complete solution for the latter has been devised. Grouting with cement, emulsified asphalt and low-melting-point asphalt has been tried, but none has proved entirely successful.

In a report by J. F. Roberts, corrosion of material in contact with water in various parts of Canada was given. In this report the various rivers are tabulated, along with remarks on the corrosive action of their waters.

Air-Break Switches

In cold climates operation of outdoor-type high-voltage air-break switches has always been a serious problem to operating engineers. A report by P. J. Croft outlined troubles experienced with this type of switch in various parts of Canada, and suggested remedies for them. These troubles include switches frozen closed, insulators sheared off on rotating-type switches, grease freezing and making the switch immovable, moisture freezing in mechanism housing, corrosion of shaft making bearings stiff, difficulty in closing high-pressure contacts with jaws sleeted over, sticking of bearings and contacts, failure of bearing lubrication, insulator breaking due to contraction of caps during temperature changes, misalignment of switches due to non-rigidity of structure, stiff operation during sleet, and weakness of mechanism brackets.

Experience reveals that the great majority of air-break switch troubles in Canada are mechanical. From information collected the committee is of the opinion that the design and manufacture of link mechanisms, that transmit the operating force to the switch element from the hand levers or other mechanism, is of paramount importance to successful operation of switches during winter.

Several cases are reported of grease or oil freezing in the switch bearings, rendering the switch immovable when no sleet was present. A certain divergence of opinion exists as to the best type of lubrication, if any, to use in air-break switch bearings. Many users report success with grease-gun lubricated bearings of an outdoor type, though several companies have fixed upon a certain brand of lubricant as a solution to these difficulties. One company at certain intervals removes the bearings and wipes them sparingly with grease as a mild lubricant and a rust preventative. While the use of greaseless ball and roller bearings is apparently new, several companies state a preference for this type of bearing.

Contacts are probably the parts most seriously affected by sleet accumulations. Trouble from this source constitutes one of the major winter-operating difficulties reported.

The committee reaches the conclusion that air-break switches, as at present furnished, are fairly satisfactory apparatus. Nevertheless, there are a sufficient number of causes of trouble to indicate that designers should continue their efforts toward producing contact arrangements that will insure satisfactory operation under sleet conditions, and of switch mechanism that are easier operated, simpler and more efficient.

DATA ON OIL-SPRAYED COAL

AT A RECENT Power Round Table meeting of the Metropolitan Section of the A.S.M.E., A. Donald of the Gulf Refining Co. explained the purpose and method of spraying coal with oil and H. E. Stoelzing gave results of preliminary tests of oil-sprayed coal fired on underfeed stokers at the Kent Ave. station of the Brooklyn Manhattan Transit Co.

Spraying of coal was first tried by a few coal mine operators for de-dusting purposes. The treatment for this purpose was found satisfactory and has been used for some time in preparing domestic fuels. About 14 mines are now spraying their coal with oil.

A straight run naphtha base oil is used having an A.P.I. of 24.5, a pour test of —40 deg., flash test of 320 deg. and viscosity of 100 sec. at 100 deg. There are two methods of spraying oil—heating to 100 deg. and spraying at low pressure, or spraying cold oil at a pressure of 350 to 425 lb. The cold method has not been satisfactory at temperatures below 0 deg. One gallon of oil is sprayed per ton of coal and will lay 75 to 85% of the dust. This processing costs about 7.5 cents per ton.

According to Mr. Donald there were indications that oil spray increased the coal ignition rate and made the fuel bed denser. This he reasoned would make the fuel bed burn deeper, increase the per cent CO_2 and reduce cinder loss, thus increasing efficiency. To determine to what extent oil spray would affect combustion, arrangements were made to conduct preliminary tests at Kent Ave.

Coal to one of the underfeed stoker fired boilers was sprayed with oil as discharged from the belt of an automatic weigh scale. Two nozzles were used which at 130 lb. pressure and 190 deg. sprayed at the rate of 2 gal. per ton. This was found to be too much oil as it made the fuel bed so dense that air would not blow through the fuel bed properly with the available underfire pressure. Changes were made to reduce the quantity of oil to 0.79 gal. per ton which was found to give much better results.

Results of these preliminary tests showed 3.9% higher efficiency with sprayed coal than with unsprayed coal. The fire was kept as nearly the same in both tests as possible. Wind-box pressure with sprayed coal was 1.58 in. with unsprayed coal 1.62 in. Cinder collected from the boiler passes was considerably less after the test with sprayed coal than with unsprayed coal. Oil-sprayed coal fed more freely to the stoker and in the stoker. Coal per stoker stroke increased from 135 lb. to 137 lb. with sprayed coal.

In the discussion that followed Mr. Reynolds of the Interborough Rapid Transit Co. indicated that oil-sprayed slack had been tried at their 59th St. station. Other discussion indicated that sprayed coal had been pulverized without difficulty, but no increase in efficiency had been observed in regular operation.

SPEAKING OF POWER

• J. I. MILLER, general manager of the Cummins Engine Co., recently wrote *Business Week* about the reported shortage of engineers qualified to sell industrial diesels. . . . A more serious shortage, according to Mr. Miller, is that of design engineers grounded in the technical fundamentals, particularly in mathematics. After criticizing both schools and students for superficial training, Mr. Miller continued: "If I wanted to make my way into the diesel industry, I would try to see to it that I got myself the most thorough engineering training that could be secured. When I had really mastered the tools of my trade then I believe I could almost name my job and salary." . . . He feels strongly that most young Americans are "suckers for short cuts."

Tool master . . .

From an editor's personal point of view the most pleasant convention of the year is the annual gathering of the American Boiler Manufacturers at Skytop, Pa. No work (for the editor). Just enough recreation and pleasant companionship in a beautiful natural setting. . . . But the dream busts up after two or three days and then it's "back to the old grindstone."

The article on page 362 reminds me again that hydrogen is a fire extinguisher. There can be no actual combustion in an atmosphere of any pure gas, combustible or not. Which in turn, reminds me of a demonstration a college professor put on at an engineers' smoker last winter which was more or less spectacular.

Extinguisher . . .

He made a fire with a little gasoline in a pan and then put it out by pouring on a lot more gasoline. . . . Don't try this experiment on my sayso, but an expert who knows "how, when and where" can use gasoline as a fire extinguisher, because gasoline cannot support combustion. The professor, if I remember rightly, made a quick job of it by pouring on a rather heavy stream. He "chilled" the fire and didn't give the new gasoline a chance to get going. . . . But, as I said before, don't try it on my sayso.

Now that the Prime Movers Section (June) is out, the next heavy grind is the firing section scheduled for September. It will round out previous sections devoted to boilers and refractories, and, we hope, have an equally enthusiastic reception from the field.

Times are getting better for the young college graduate—and it's about time, for he certainly took the rap during the depression. I hear that about four times as many company representatives interviewed students as did last year. Chemical engineers are in greatest demand; four out of five of the new chemical grads are getting jobs. Mechanical engineers come next; then electrical, mining and civil in that order.

I had figured on a personal trip to Dallas for the A.S.M.E. meeting in that fast-moving city. Then I remembered my own recent junkets to Europe and Chicago and decided it was time to give some other member of the staff a chance. So Associate Editor Tangerman went to Dallas, incidentally making calls on the way in Chicago, St. Louis, Kansas City and Tulsa. This trip, by the way, gave Tange a good first-hand view of steam, diesel and air conditioning progress in the Southwest. . . . You will undoubtedly see repercussions in future numbers.

. . . repercussions

At the Dallas A.S.M.E. meeting Prof. M. C. Stuart, Lehigh University's astute professor of thermo, and D. Robert Yarnall, Philadelphia manufacturer, joined hands in a paper analyzing neatly what happens when steam or hot water is blown through two orifices in series. The in-between pressure cuts some peculiar capers, which have been utilized to build an ultra-simple trap that will blow water and hold steam.

What interests me is that the trap itself was well developed first and the theory comes afterwards. Like baseball. First pitchers learned to pitch curves and then the scientists came along and proved theoretically that it could be done. . . . Intuition first, then analysis; that seems to be the usual order. It certainly was with the boiler, the steam engine and the steam turbine. We even had airplanes before we had any aerodynamics worth mentioning.

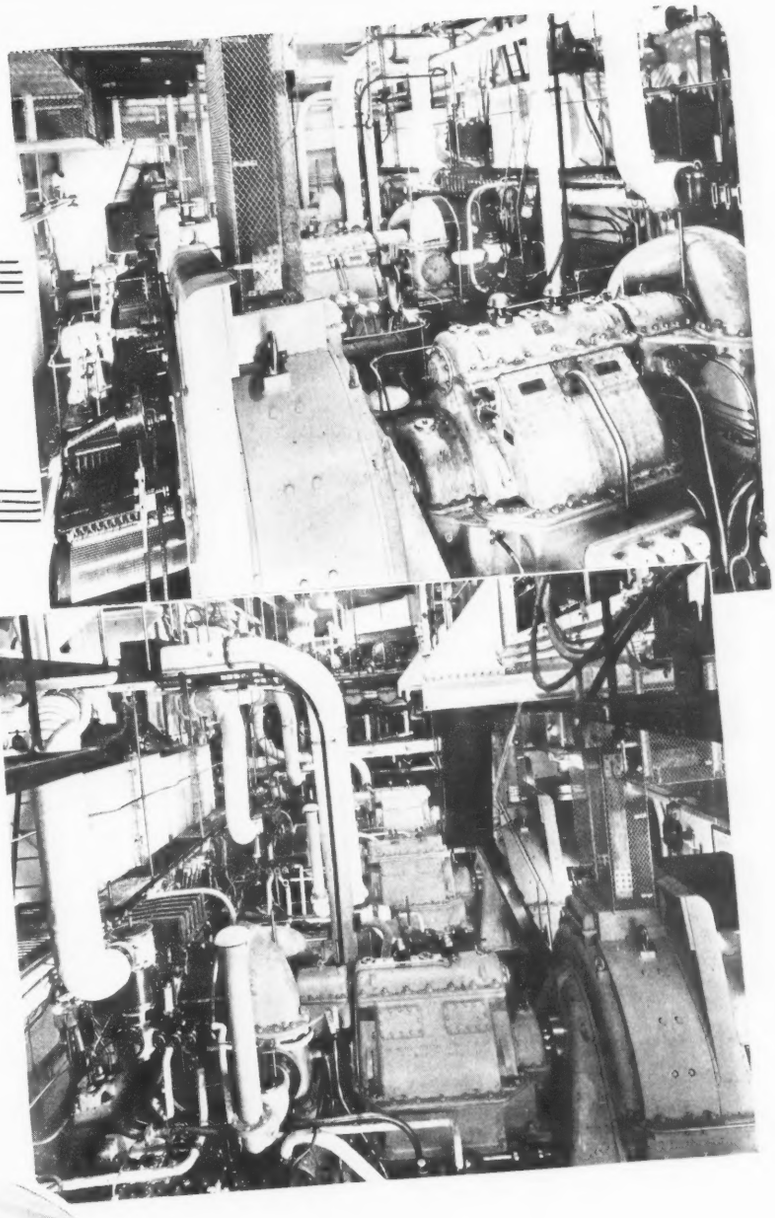
In my opinion water and steam have many other smart tricks up their sleeves waiting to be discovered by the coming generation. Can engineering schools train or inspire their brighter students to discover by analysis as well as to analyze after discovery?

During odd weeks and days the editors hope to steal their brief vacations according to their individual ideas of what's restful. Mine, as usual, is sailing a sloop on Long Island Sound with turns in the home workshop on rainy days. . . . With typical inconsistency, I am proud to point out that the boat has no engine, is devoid of lubrication, has a low power factor (operates on wattless currents), and will never attain 100% availability. Horsepower probably reaches five or ten on a windy day. On the other hand, fuel consumption per horsepower hour is zero—considerably less than the best diesel engine or mercury-steam plant.

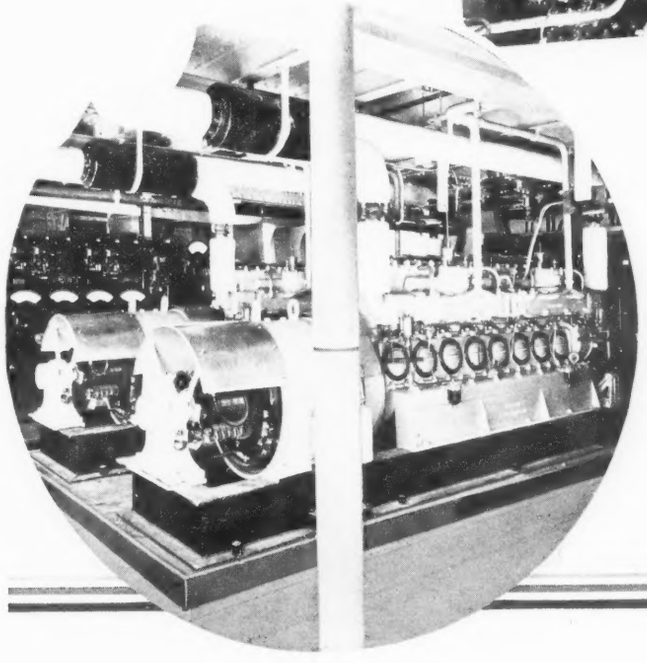
. . . wind hp.

PHIL SWAIN
Editor

QUEEN MARY

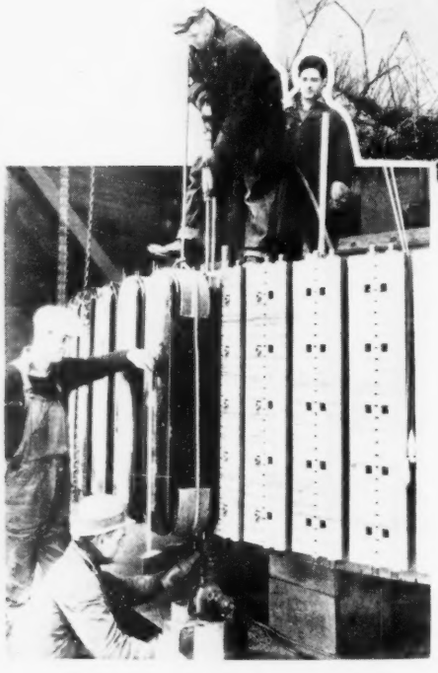


Largest floating power plant is that of Britain's new superliner. At right are her two auxiliary turbine rooms, below her emergency gasoline engines. These auxiliaries provide 9,250 kw. of direct current in addition to her 200,000 s.hp. in main turbines. No photographs of main units are permitted thus far



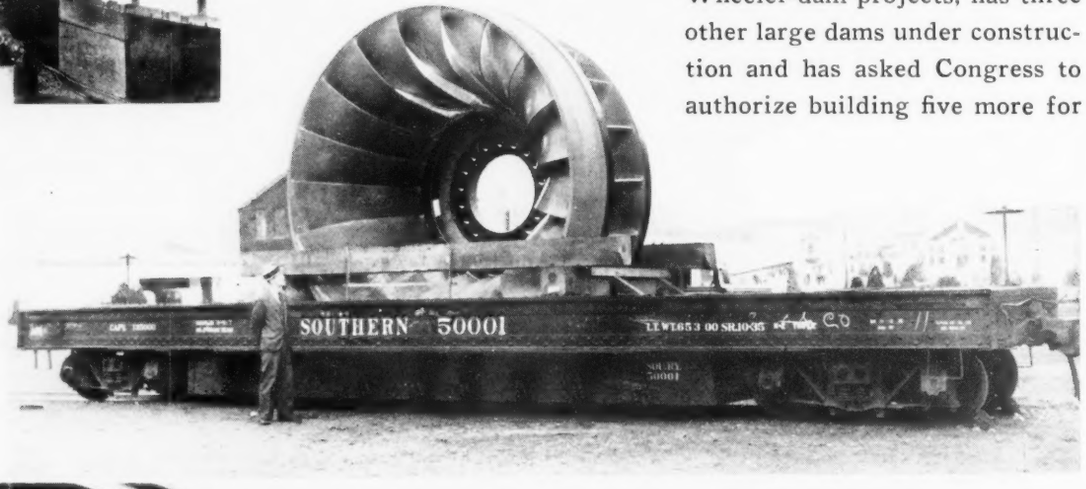
Forward auxiliary turbo-generator room (top) has three 1,300-kw., 5,000-r.p.m. turbines (one a spare) geared down to drive 600-r.p.m., 220-volt generators. It supplies power for services and deck machinery. The after room (above) has four similar units (one a spare) and provides power for pumps and boiler auxiliaries. Two 75-kw. gasoline-engine sets are for emergencies. See May *Power*, page 255.

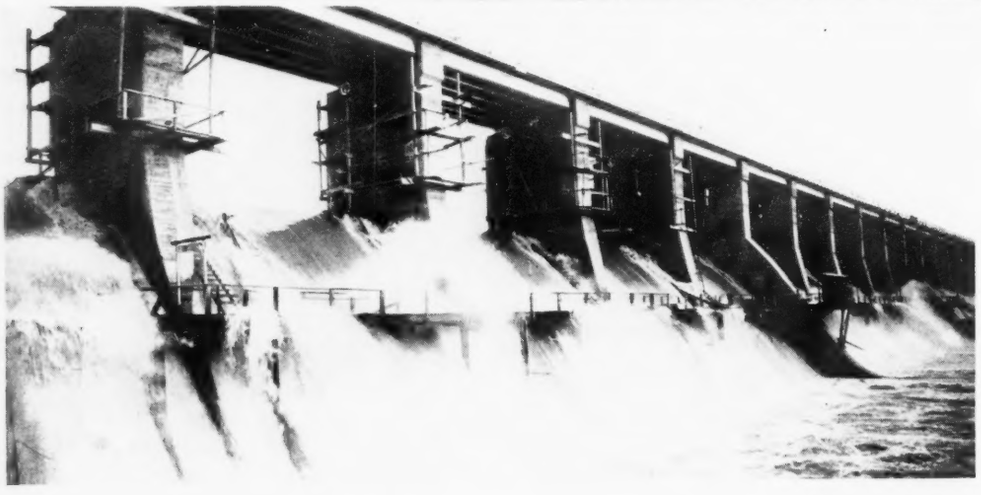
Right — Norris dam and power house as they appeared on March 31 of this year. The dam with a maximum height of 265 ft. provides a reservoir of 3,600,000 acre-ft. storage capacity and a power installation of 132,000 hp. Below — Putting field poles on the rotor of one of two 36,000-kva. generators being installed on Wheeler-dam plant



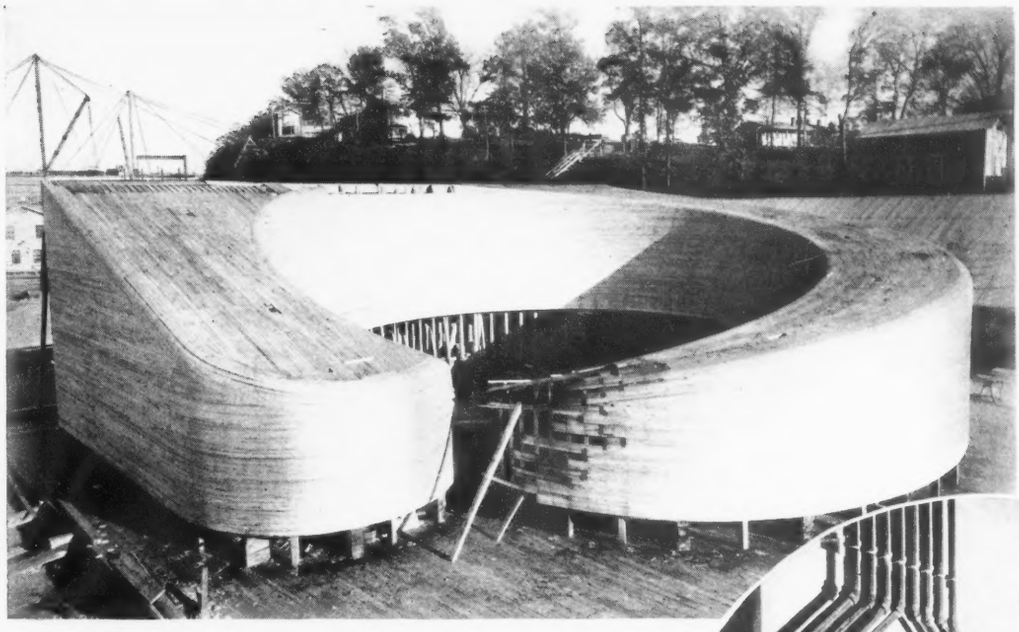
T. V. A.

Created by an act of Congress, signed by the President, May 18, 1933, the Tennessee Valley Authority has since then practically completed building Norris- and Wheeler-dam projects, has three other large dams under construction and has asked Congress to authorize building five more for

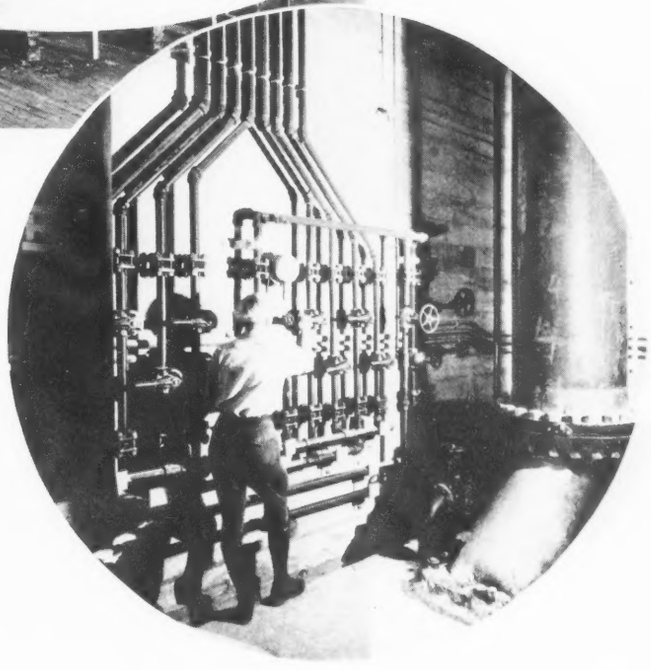




Above—Turbine runner for one of two 66,000-hp. units for Norris-dam plant. This runner is cast in one piece, weighs 45 tons, is 14.5 ft. in diameter and 7 ft. high. Left—Flood water passing over Wheeler-dam spillway last spring, which is designed to discharge 500,000 sec.-ft.

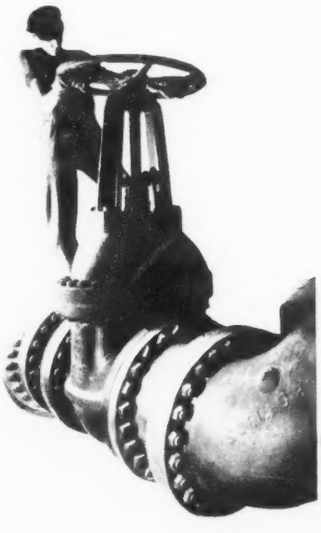


Left—Part of scroll-case form for one of the two 45,000-hp. propeller-type turbines being installed in Wheeler-dam plant. At full load each turbine will require 9,150 cu.ft. of water per second. Below—Control for the 5-ft. 8-in. by 10-ft. gate valves in two of the eight sluiceways through Norris dam



At Work

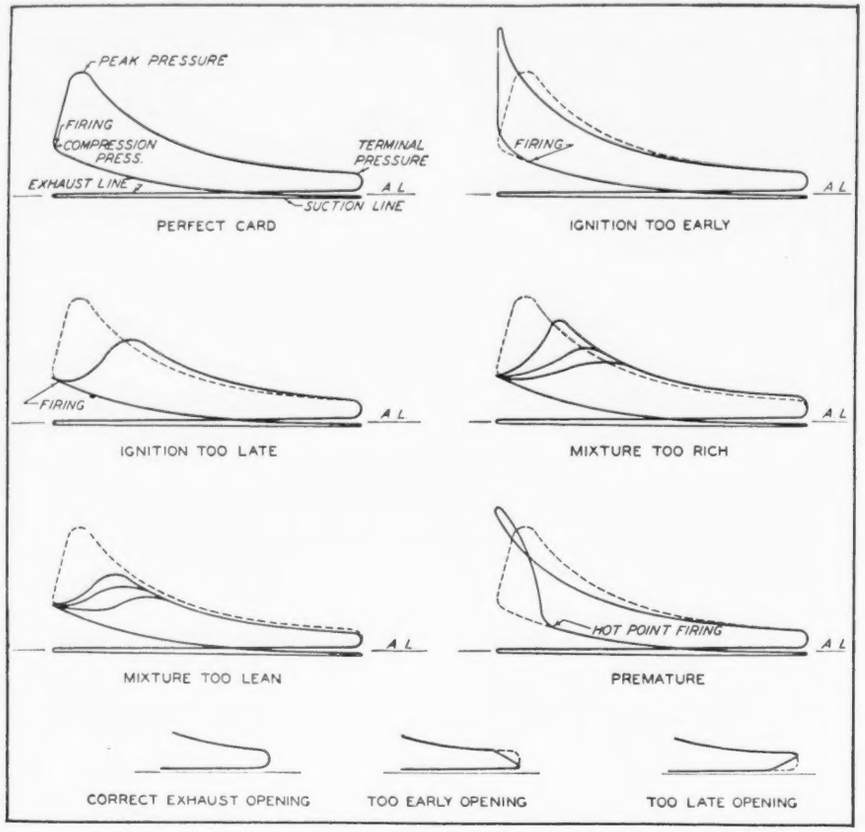
flood control, river regulation, navigation and power generation on the Tennessee River and its tributaries. These projects will provide 650 mi. of 9-ft. navigation and a possible power installation of 2,750,000 hp., at a cost of approximately $500,000,000 (see pages 354 to 357).

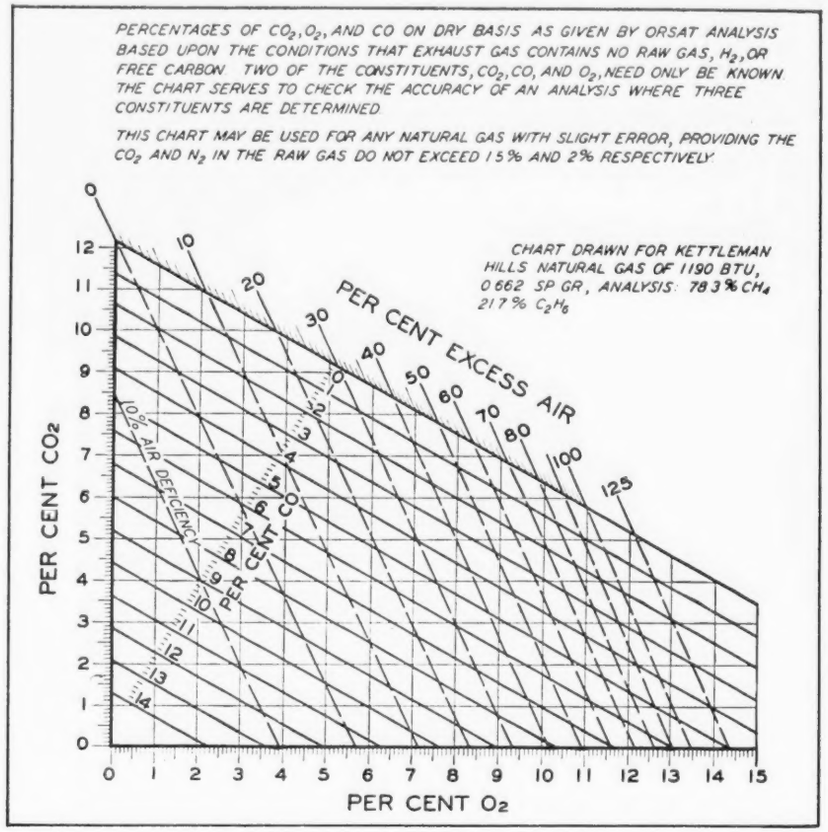


Left—Bypass valve in main gallery of Norris dam for filling one of two turbine penstocks before opening the head gates. Below—A 135-ton test load on one hook of the 270-ton main gantry crane at Wheeler-dam plant, which is of the outdoor type

© POWER

Gas-Engine Indicator Cards and Exhaust-Gas Analysis




PERCENTAGES OF CO2, O2, AND CO ON DRY BASIS AS GIVEN BY ORSAT ANALYSIS BASED UPON THE CONDITIONS THAT EXHAUST GAS CONTAINS NO RAW GAS, H2, OR FREE CARBON. TWO OF THE CONSTITUENTS, CO2, CO, AND O2, NEED ONLY BE KNOWN. THE CHART SERVES TO CHECK THE ACCURACY OF AN ANALYSIS WHERE THREE CONSTITUENTS ARE DETERMINED.
THIS CHART MAY BE USED FOR ANY NATURAL GAS WITH SLIGHT ERROR, PROVIDING THE CO2 AND N2 IN THE RAW GAS DO NOT EXCEED 15% AND 2% RESPECTIVELY.
CHART DRAWN FOR KETTLEMAN HILLS NATURAL GAS OF 1190 BTU, 0.662 SP GR, ANALYSIS: 78.3% CH4, 21.7% C2H6
PER CENT EXCESS AIR
10% AIR DEFICIENCY
PER CENT CO
PER CENT CO2
PER CENT O2

THE indicator is particularly useful in checking performance of large, slow-or medium-speed units, showing ignition and valve timing, prematures, mixtures, and compression, peak, terminal, and back pressures. Keep full-load compression pressures high as possible without causing premature ignition (for natural gas with oil- or water-cooled pistons 115 to 130 lb. per sq.in., with non-cooled pistons 80 to 110 lb.)

Keep peak pressures as low as possible without reducing mean effective pressure. Avoid excessive peak pressures because of abuse of engine parts and because accompanying higher temperatures increase heat loss to jacket water. High peak pressures are due to early timing or prematures. Make terminal pressures as low as possible, or latent expansive power will be lost in the exhaust. High terminal pressures are caused by late ignition and too rich a mixture. High back pressures, sometimes caused by installation of mufflers or heaters in exhaust lines, reduce the amount of fresh air that can be drawn into the engine.

Late ignition causes serious losses in m.e.p. The engine still runs smoothly under this condition, and this effect is often unsuspected unless a serious loss of power occurs.

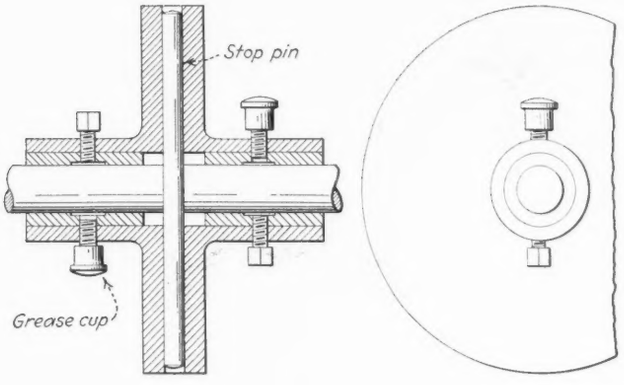
Time exhaust valve opening so that the toe of the card is well rounded. If openings and closings of inlet and exhaust valves do not coincide with a perfect card, usual practice is to favor the exhaust valve when retiming the valve system.

Erratic and poorly shaped cards are caused by improper mixtures, either too rich or too lean. Use the leanest possible mixture that will carry the load and give well-shaped cards. Too lean a mixture causes backfiring. Possible causes of prematures are: hot spot in center of uncooled pistons, insufficient jacket cooling or scaled jacket, excessive compression, overheated exhaust valve, badly timed ignition.

The indicator alone will not assure correct timing and proper mixture, for a mixture either too rich or too lean burns more slowly than a theoretical mixture and may appear to be corrected by earlier ignition to get a well-rounded card, so an Orsat should be used to get proper mixture before valve timing is changed. While some unburned gases usually appear in the exhaust, the diagram at right gives a quick and fairly reliable check on leanness or richness of mixture. Excess air and carbon monoxide of course should both be at a minimum and carbon dioxide a maximum. Under ordinary conditions, keep CO as low as possible, even though excess air may be a little high. This gives minimum fuel loss. When a low CO cannot be realized without excessive air, the reason is usually an improper mixing valve. A fair degree of turbulence in the valve is conducive to complete combustion.

Extracted from "Gas Engineers' Handbook," McGraw-Hill Book Co.

PRACTICAL AIDS TO OPERATION



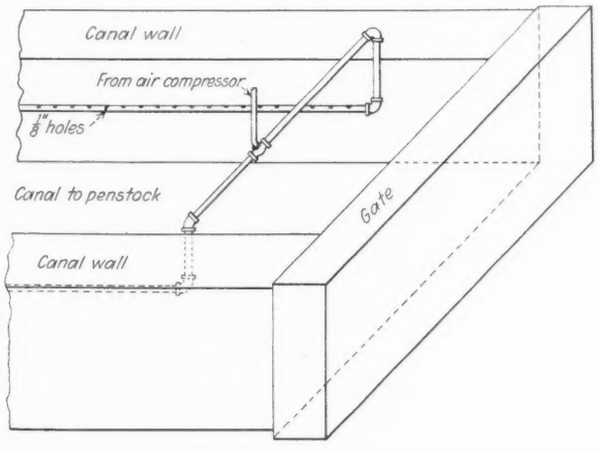
Combination Tight and Loose Pulley

IT WAS necessary to divide a small countershaft into two sections. Ordinarily, the whole shaft was driven by an 8-in. pulley, but at times it was required to stop one half while the other was running. A special tight and loose pulley in one piece was obtained with an especially long hub, as in the diagram. The hub bushing has a clearance where the tightening screws are, so that any burrs caused by the screws will not cut the bushing.

A hole was drilled through the pulley for a stop pin that was driven in when the pulley was in place. This pin prevents the pulley from gradually sliding out of place as the screws are adjusted from time to time.

With both screws tightened, the whole shaft is driven. To drive either half and stop the other one, its screw is loosened so that it runs loose while the other half drives.

Hamilton, Ont. FRANK MOORE



Bubbler Pipes Prevent Ice Formation

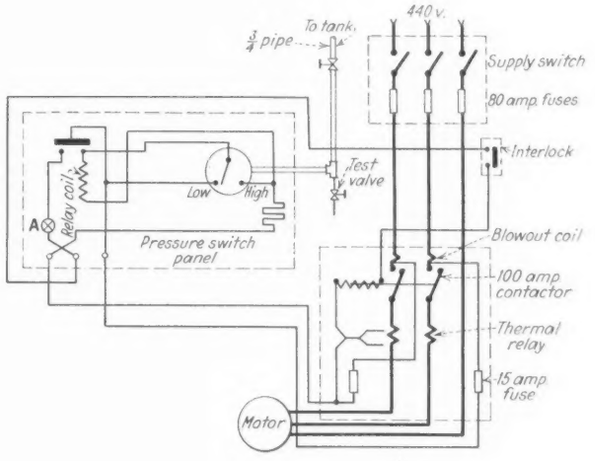
A HYDRO-ELECTRIC plant experienced difficulties in severe cold weather, during periods of light load, from ice forming along the canal walls. The canal from the reservoir to the penstock gate was about 50 ft. long, A 1¼-in. pipe, having ⅛-in. holes 3 in. apart drilled in it, was laid horizontally on each side of the canal wall, as in the diagram. These pipes were located about 2 ft. below average mean water level and connected to the plant compressed-air system. Compressed air escaping through the holes under water caused bubbling along the sides of the canal wall to prevent formation of ice, and eliminated the previous trouble.

Chicago, Ill. R. O. BILLINGS

Interlock Prevents Overloading Safety Switch

IN OUR plant, water pressure is maintained at 260 to 275 lb. per sq.in. by a triplex pump direct-connected to a 20-hp., 440-volt squirrel-cage induction motor started on full voltage. Starting is automatic from a pressure switch acting through a relay and a 2-pole contactor.

A serious accident occurred in connection with this pump



due to the motor contactor closing just as the line safety switch was opened. This switch was not designed to interrupt motor starting current, and as a result it short-circuited, causing an explosion that opened the switch door and severely burned the workman. A safety switch of higher rating was installed with an interlock operated by the switch handle. A snap switch, *A*, was also installed to open the contactor-coil circuit before opening the line switch. Even though switch *A* is not opened before the line switch, the interlock will insure safe operation of this switch, by dropping out the motor contactor if it happens to be closed, or preventing its closing when it is open.

Pittsburg, Calif. RAY BARR GLENN

Caustic Treatment for Boiler-Scale Removal

REMOVAL of scale from internal surfaces of steam boilers is a difficult task at best. Often it is impossible to remove it mechanically from inaccessible parts. Some feedwater treatments will loosen it, but this is usually a slow process which, if hastened, may prove dangerous. Such difficulty occurs especially at high ratings. Loose scale drops and lodges in the lower rows of tubes of water-tube boilers or on the lower shell plates of fire-tube boilers, and serious overheating, bulging, or even explosion may result.

If it is possible to take the boiler out of service for about 36 hr., much of the scale may be removed by a caustic treatment. Open the boiler and place in it (without passing through the feed pump) a solution consisting of 75 lb. of caustic soda per 1,000 gal. of water capacity of boiler at normal operating level. Dissolve the caustic soda in hot water, put it into the boiler filled with sufficient water to deconcentrate the solution considerably, and bring water level to a little above normal. If scale or incrustation deposited from foaming appears in the steam space, raise the water level high enough to cover this section.

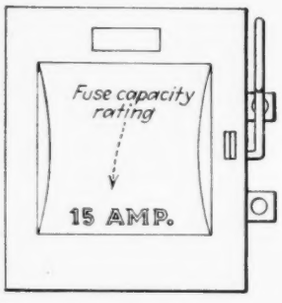
Leave the manhole plate out of boilers having a manhole in the upper part of shell or drum. If the manhole is below the water line, vent the boiler to prevent steam pressure increasing to more than 2 or 3% of operating value.

Start a slow fire in the furnace and maintain it to boil the solution in the boiler for 24 hr., after which cool and drain the boiler. Remove all manhole and handhole plates and tube caps and flush the internal surfaces with a high-pressure stream of water. The boiling process rots the scale, causing it to become loose and easily detachable. In extreme cases, repeat the treatment.

It is important to remove all loose scale so that during operation it will not drop onto high-temperature surfaces and cause overheating of plates or tubes of the boiler.

Columbus, O. J. R. WILLIAMS

Fuse Rating on Switch Box



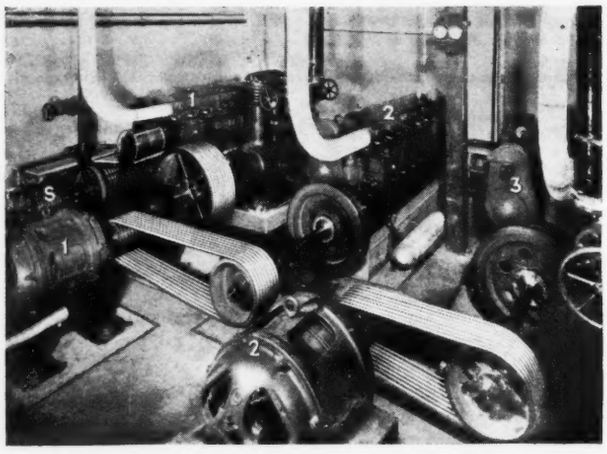
IN PLANTS where there are a large number of fused electrical switches enclosed in metal boxes, it will be more convenient for fuse replacement if the capacity of the fuses used in each box be stenciled on its outside, as in the diagram. This eliminates the necessity of trying to read the fuse capacity on its ferrule or paper label. If the capacity of the fuses in a circuit be changed, the old capacity number should be replaced with the new one.

Baltimore, Md. THOMAS TRAIL

Flexible Arrangement of Drivers Insures Reliability

AT THE Rialto Theater, Dallas, Texas, an interesting combination of drives has been applied to the electric generators and refrigerating compressors to insure reliability. Power equipment includes two 75-kw. generators and two 90-ton refrigerating compressors, each driven by a gas engine through multiple V-belts. One compressor and the two power-generating units are shown in the photo.

Since operation of the generators is absolutely essential to the theater they were arranged so that each can be driven by two of three gas engines. Normally, as in the figure, No. 1 engine drives a compressor, No. 2 engine drives No. 1

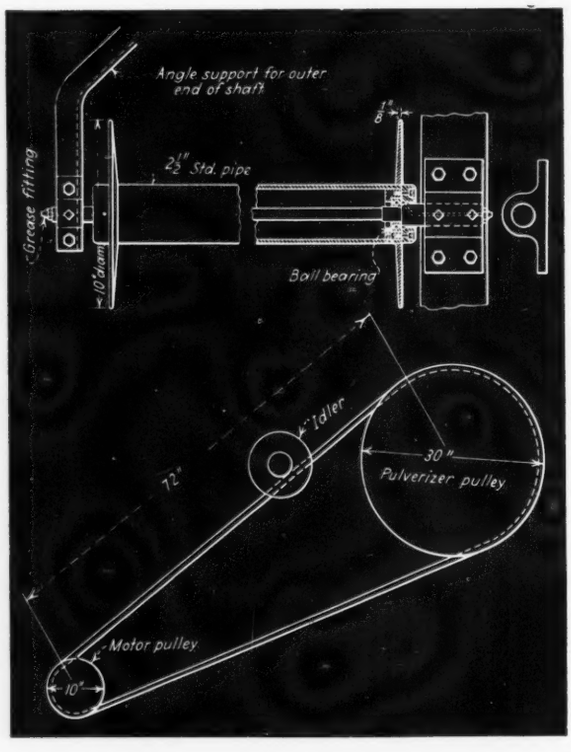


generator, and No. 3 engine No. 2 generator. The generators and engines are so placed that if No. 2 engine fails, No. 1 generator can be driven by No. 1 engine from an extra sheave *S* on an extension of the engine shaft. The generator's location is such that the same V-belts can be used for either drive. If No. 3 engine fails, No. 2 generator can be belted to No. 2 engine and No. 1 generator to the extra sheave on No. 1 engine. This arrangement practically insures 100% reliability of the power plant and allows taking one engine out of service for overhauling.

Denver, Colo. M. NASBY,
The Gates Rubber Co.

Application of Idler Keeps V-Belts in Service

WE HAVE applied an idler to the outside of a V-belt drive, not for adjusting tension, but to keep the drive in service and get several more months use out of it. This drive comprises a 14-strand V-belt connecting a 100-hp. adjustable-speed motor to a coal pulverizer. The carrier-air fan is



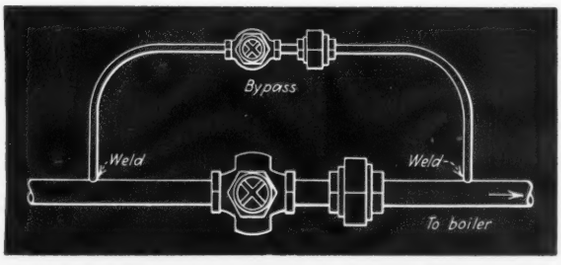
mounted directly on the motor shaft, hence the V-belts drive the grinding element only. Tension on the belts is adjusted by moving the motor.

After the mill had been in operation for some time and the belts had taken their maximum stretch, it was found that some had stretched slightly more than others. The longer ones tended to wave badly sidewise as well as up and down at certain loading on the mill. The real cause of the trouble was not so much due to stretch as to short sections of certain belts becoming slightly smaller in cross-section. This in turn allowed these section to draw deeper into the pulley grooves, causing a distinct wave to the belts as they approached the larger pulley. After the outer belt had run off the pulley a couple of times and one of the inner belts had run up on top of an adjacent one and broke, the idler shown in the figure was applied.

The idler was mounted between the two pulleys at a point where the wave appeared to be the greatest and was adjusted so that the belts would just touch it with the mill at rest. When the mill is first started, the idler picks up considerable speed, but as the load on the mill is increased and the belts stretch the idler decreases in speed and finally stops, being moved only occasionally by the friction of the belts rubbing it at the top of the wave. The belts that have stretched uniformly do not touch it at all, it serving only to steady out some of the waving of the other belts and prevent them leaving the grooves. The general design of the idler, which is adjustably mounted, with the spindle supported at each end, will be readily understood from the drawing.

Although it may appear that the practical cure for the trouble was a complete new set of belts, a spare set was not available at the time, and, furthermore, the existing ones had only been in use a comparatively short time. The application of the idler got us out of trouble and the belts remained in service without further trouble for about a year.

Winnipeg, Man. C. L. ALEXANDER



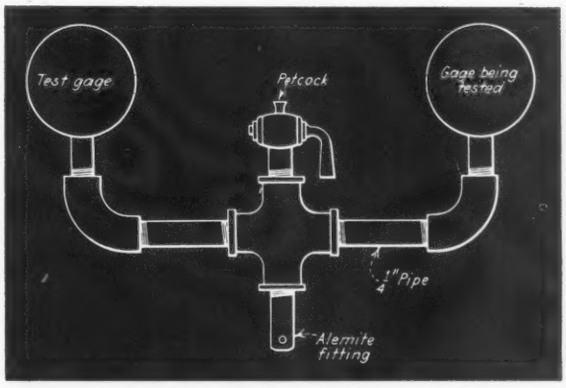
Bypass for Boiler Feedwater Control

IN PLANTS where a number of comparatively small boilers are used the feedwater line to each boiler may be fitted with one valve in addition to the usual check. Steam consumption in such installations may run fairly constant for hours at a time. It is common practice for the firemen to pinch down on the feed valve so as to deliver to each boiler approximately the amount of water being taken away as steam. The valve may be nearly closed to secure this desired regulation, with consequent cutting or wire-drawing of the sealing surfaces causing leakage or loss of control of water flow.

To provide this regulation in one installation the feedwater line was provided with a bypass as shown in the diagram. The main feed-water line is one-inch pipe and the bypass is made $\frac{3}{8}$ in. in diameter. As long as the bypass will supply sufficient water to the boiler, the main valve is kept closed and the flow regulated by the smaller valve. Since the bypass valve is small compared to the main line it probably will be run nearly open, and thus greatly reduce the wear.

Where a welder is available the bypass can be welded into the main feed-water line, and thus avoid the additional pipe joints required for an all-screwed hookup.

Longview, Texas. ELTON STERRETT



Makes Pressure-Gage Testing Set

EVERY plant has the problem of testing pressure gages, and there are many plants lacking proper apparatus and an appropriation is not available to purchase one. The diagram shows how this problem was solved in one plant.

An accurate test gage, a pet cock and alemite fitting were assembled, as indicated, with 0.25-in. pipe and a cross coupling. The gage to be tested is connected as shown and pressure applied with an alemite grease gun, a light oil being used as the pressure fluid. This gage can be moved through its full range and a check made at any number of desired points. If the check valve has been removed from the gun, test pressure can be reduced by backing off on the gun's piston. Otherwise, the pressure is relieved by the pet cock.

Westfield, N. Y. K. W. SEITER

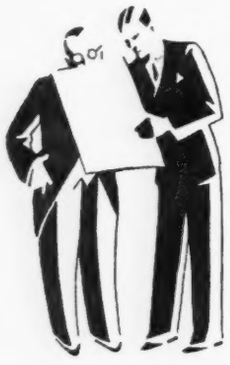
Dead Space Causes Economizer Explosion

A SERIOUS explosion occurred in an economizer due to ignition of an accumulation of combustible gas in a dead space. Gas from two boilers passed through the same economizer. When the explosion occurred only one boiler had been working on light load for some time. The gas from this boiler flowed through the economizer in such a way as to leave a large dead space in its casing where combustible gas must have accummulated. Shortly after the firing rate had been increased in preparation for oncoming load an explosion occurred in the economizer casing that did considerable damage.

The cause of the explosion was attributed to flame or a spark from the fire igniting combustible gas in the dead space in the economizer. This experience emphasizes the necessity of avoiding dead space in the design and construction of flues and breechings for boiler.

Orpington, England W. E. WARNER

CURRENT COMMENT



Forward Curved Fans in Parallel?

IN HIS reply to my discussion of his article on Parallel Operation of Fans, Mr. Kice evaded the issue. In his original article he "rested his case" on a graphical analysis of fan curves. In my discussion I used his own methods and curves, but with a more thorough analysis, and arrived at an opposite conclusion.

Commenting on my discussion, Mr. Kice speaks disparagingly of mathematics, minimizes my experience and accuses me of bias. He does not, however, take my curves and point out specific errors, as I did with his.

He further attempts to confuse the issue by introducing a new consideration, that of stability, which doesn't belong in this argument. Fans are either stable or not stable. If they are not stable, they warrant no consideration of any sort. If they are stable, they perform in accordance with their characteristic curves and their action in parallel can be analyzed from these curves.

It is desirable to arrive at some conclusion from all this discourse, if at all possible. Is the following a fair summing up? Analysis based on fan characteristics indicates that forwardly curved blade fans cannot be relied upon to operate successfully in parallel. Practical results of both failures and successes—when sifted by good judgment—constitute complete agreement between theory and practice.

Hyde Park, Boston, Mass. H. F. HAGEN
B. F. Sturtevant Co.

What's Wrong With This Picture

REFERRING to Mr. Harry Spring's sketch of a tubular boiler (March, *Power*), I am submitting the following additional errors:

1. The boiler appears to be over 500 sq.ft. and, therefore, at least two safety valves would be needed—Par. 269 of the A.S.M.E. Code.
2. No drain is shown in the casing of the safety valve, as per Par. 278 of the A.S.M.E. Code.
3. The sketch does not show the boiler as being pitched 1½ to 2 in. at the rear end, that is lower at the rear end than at the front end.
4. Feed line in the shell of a boiler over 40 in. should have the feed pipe discharge back ⅔ of the length of the boiler, as per Par. 314 of the A.S.M.E. Code.
5. There is no flange or bushing on the shell for the feed pipe, as per Par. 315 of the A.S.M.E. Code.
6. A fusible plug is not mandatory—Par. 298 of the A.S.M.E. Code. If used it should not be less than 1 in. above the upper row of tubes, measurement to be taken from the line of the upper surface of tubes to the center of the plug and projecting through the sheet not less than 1 in.;—such projection is not shown in the sketch.
7. The rear arch appears to be too high and should be installed so that the rear head will be protected by water at all times.
8. An elbow is shown on the blow off pipe and it is preferable to have a right angle bent pipe instead of an elbow.
9. Steam line is not supported.
10. Upper connection of the water column should be taken from the top of the shell so that it will not be eaten away by the gases of combustion.
11. The manhole only shows one row of rivets, whereas all boilers over 48 in. in diameter should have a double row of rivets.
12. The tubes appear to be too close to the bottom of the shell of the boiler, and also there are no handhole plates or other openings shown below the tubes for the purpose of cleaning.
13. No dry pipe or baffle is shown to reduce wet condition of steam.
14. The brickwork at the front end should be provided with a small door for the purpose of seeing the bottom of the shell plates while the boiler is in service.
15. The dry sheet at the front end of the boiler should be provided with a ½" hole for the purpose of draining off any water that might accumulate at this spot.
16. If the boiler is an A.S.M.E. boiler, there should be a manhole in the front head below the tubes, if it is 48 in. or over in diameter.

Buffalo, N. Y. JOHN TIMMONS

Cost of Reconditioning More Than Brine Is Worth

IN APRIL, several readers of *Power* suggested methods of purifying ammonia-contaminated brine. Economics of treatment indicate reconditioning costs more than brine is worth. Let it be assumed that the brine was an approximate 20% solution of either sodium chloride or calcium chloride (freezing point near 0 deg. F.). Either kind would, then, have contained roughly 2 lb. of salt to the gallon, making a total of 5,000 lb. of salt. Value of the brine, exclusive of cost of preparation, of water, and of any corrosion retarder used, was in excess of $40, for NaCl brine made from salt at $16 a ton; perhaps more than $70 for $CaCl_2$ brine. For neutralization of the ammonia, the CO_2 required would slightly exceed 2½ lb. for each pound of ammonia gas, making a total of 500 lb. needed if all ammonia remained to be neutralized. The cost of liquid CO_2 in cylinders might have been as much as $0.10 a lb., or $50 in total, possibly not over $30. Even at these figures, recovery of the brine would perhaps have appeared eminently advantageous. The convenience and comparative safety of gradually lowering the brine alkalinity by slowly running in CO_2 has much to recommend it. The gas could have been introduced through a length of small iron pipe terminating near the bottom of the tank, near an agitator or pump.

Had muriatic acid been used, there would have been required roughly 2 lb. of HCl for each pound of ammonia. The needed 400 lb. of HCl would have been contained by approximately 1,200 lb. (123 gal.) of concentrated hydrochloric acid. That would have cost anywhere from about $20, works price, to nearly $70 at a common price of $7 for a 125-lb. carboy. Mixing of such large quantities of acid into brine in an ice plant is a hazardous procedure. Supervision by a good practical chemist or chemical engineer is warranted by the risk and costs involved.

It is apparent that no simple or off-hand procedure properly applies to solution of this problem, or, for that matter, to any of the many chemical problems of the ice plant.

Corvallis, Ore. R. E. SUMMERS

How Wide a Gasket?

REFERRING to Emil J. Novak's comment on gaskets in May *Power*, I would suggest that a full face gasket has its legitimate use in pipelines under a vacuum such as vacuum exhaust lines, to prevent the gasket from being sucked into the line. For pressure piping, however, the ring-type gasket is the one to use. A still better joint is obtained if a raised facing strip is used. Its outside diameter is smaller than the circle inside the bolt holes and it is usually raised $\frac{1}{16}$ in. The outside diameter of the ring gasket still remaining equal to the circle inside of the bolt holes and is compressed between the two raised faces, an area usually approximately two thirds the area of the ring gasket. A better method, but one not commonly used, is to have the raised facing strip about one third the width of the ring gasket. If, for instance, the ring gasket is 1½ in. wide, the facing strip is one-half in. wide.

Pittsburgh, Pa. BERNARD KRAMER

More Errors In "What's Wrong"

ON PAGE 279 of May *Power* is a picture of a vertical tubular boiler having 16 errors in installation listed on page 281. I am submitting herewith additional information which I believe should be added to the errors listed, and numbered to correspond to the numbers of the original.

2. A safety valve exceeding 2 in. must have the valve drain tapped and should be piped to a safe point of waste.
3. The safety valve connection on the

boiler must be flanged, and to have the safety valve set upright would require a flanged elbow between flanged boiler connection and safety valve. The safety valve flange, flanged elbow, and flanged boiler connection would of necessity be in accordance with A.S.M.E. Code requirements. On removing the safety valve from the 3-in. steam line, this steam line would be required to have a stop valve with outside screw and yoke rising-spindle type installed close to the boiler and preferably in an upright position.

5. I agree that the safe water line for lower tube sheet is $\frac{1}{3}$ the length of the tubes from lower tube sheet, but for the good of the upper ends of the tubes in this type boiler, the safe water line should be at least $\frac{2}{3}$ the length of the tubes, measuring from the lower tube sheet. Nearly all vertical boilers have the water glass and gage cocks set at or about this point.

6. The drain pipe from lower gage-glass connection to the drain valve must be extra heavy, and the drain valve must be of sufficient strength to withstand a pressure 25% in excess of the pressure carried on the boiler, and so stamped. In this case the valve would be stamped approximately 200 lb. The discharge pipe from this drain must be carried to a safe point of waste.

7. On this boiler the feedwater pipe should be extra heavy from the check valve to the boiler. The check valve and the stop valve must be of sufficient strength to withstand a pressure 25% in excess of the pressure carried on the boiler, and so stamped. Feedwater must enter under the disc of all globe valves in the feed line. If tees or elbows are used in the feed line between the check valve and boiler they must be extra heavy.

8. Paragraph 314 of A.S.M.E. Code also allows feedwater to be introduced in this type boiler in close proximity to riveted joints or hot furnace sheets by fitting a baffle inside the boiler to divert the inflow of feed water.

9. On this boiler the blow off pipe must be extra heavy, and the elbow must be of steel.

10. The pipe used in the lower connection to the water column on this boiler must be extra heavy, and each right angled turn must be provided with extra heavy crosses to facilitate cleaning. Drain pipe from the water column to the drain valve must be extra heavy, and the drain valve must be strong enough to stand a pressure 25% above the pressure carried on the boiler, and so stamped. Discharge from this drain valve must be carried to a safe point of waste.

12. If the steam line to the pump is of over 2-in. pipe it would require an outside screw and yoke rising spindle type valve set close to the boiler and in an upright position.

13. The stop valve, which is necessary as a throttle valve, is located too near the pump cylinder to install a sight feed lubricator between the throttle valve and pump.

14. I would recommend the oil burner be of a type which could be installed in the ash pit in order to get complete combustion of fuel in suspension within the fire box.

15. The two slow opening valves required on the blow off must be extra heavy and good for a pressure of 250 lb. If a cock were used as one of the valves it must have the plug held in place by a guard or gland (not the type in the picture which appears to be a common plug cock). A slow opening valve is one which requires at least five complete turns of the operating means to change from full closed to full open, and vice versa. The discharge from the blow off valves must be carried to a safe point of waste.

16. In connecting the steam gage to the steam space it would require a brass syphon, or equivalent device, to keep the gage tube filled with water when the boiler is in operation. Also a tee- or lever-handled shut off under the gage, and a test gage connection. All pipe and fittings, including test gage connection, must be of brass. If steam gage vibrates it should be anchored.

If the boiler shell is not of sufficient thickness, all threaded openings must be reinforced to give the required number of threads.

It would be a convenience to have a clean out, or inspection opening, in the side of the uptake with a removable cover plate attached to the uptake by lugs, studs, or other means to prevent it from being blown off in case of a gas explosion.

Albany, N. Y. S. A. BOWEN

Compressed-Air Explosions Are Preventable

IF, as has been pointed out in these pages recently, we do not know what causes air-receiver explosions, are we to conclude that these explosions are to be accepted in the regular operation of an air compressor? Certainly not! Air-receiver explosions are preventable and are inexcusable.

When an inflammable gas, or a mechanical mixture of air and inflammable liquid, comes in contact with heat above the flash point of the mixture, burning takes place. If the burning is very fast we call it an explosion. Any factor contributing to these conditions promote air-tank explosions. Their elimination will eliminate such failures.

Use only air tanks and piping designed for the pressure to be carried. Domestic hot-water boilers are not designed for air tanks. The A.S.M.E. Code for Unfired Pressure Vessels is a safe rule to follow in the construction or purchase of receivers.

The air compressor itself may contribute to the explosion hazard by its design or operating condition. This may be the lubricating oil or it may be an inflammable gas sucked into the compressor through the intake or even a highly combustible dust, such as coal dust.

Elimination of dangerous conditions may seem so simple as to require no further discussion, but all the possibilities of lubricant trouble have not been given due consideration. Excess lubrication in some cases is entirely the fault of the engineer and can be corrected by him at will, but in others it is not so simple. Worn pistons and cylinders; stuck, gummed, or worn out piston rings will, of course, cause trouble, more particularly during the period of unloading.

When the compressor is compressing air, pressure in the cylinder tends to drive back any oil that is between the piston and the cylinder wall. The more space there is, the more the lubricant will be blown back, and the faster will be the wear. When the compressor is unloaded this pressure is not present and the oil works up into the compression space. If the compressor is of the type that unloads by closing the intake, each outward stroke of the piston tends to create a vacuum in the cylinder that is conducive to drawing an excess of oil into the cylinders. With this type of unloader the air in the cylinder is expanded and compressed, high temperatures develop and a possible explosion and tank failure may occur if the elements are present.

With the type of unloaded compressor that holds the intake valves open, outward movement of the piston draws in a charge of fresh cool air. The return stroke forces this air through the intake valve to the atmosphere. There is no tendency to draw excess oil into the cylinder, and the temperature of the cylinder walls, pistons and valves is reduced. Even if the discharge valve leaks considerably, the leaked air will be returned to atmosphere through the open intake valve.

Lubricating oil itself creates no end of trouble. A high-grade oil is so much cheaper in the long run that we wonder why engineers are kidded into using the poorer grades. A cheap oil will not stand up under heat. The lighter ends, which are the more explosive, distill off. After the light ends distill off the heavier gum up and cause discharge valve trouble, and form carbon.

Air cleaning is of first importance, not only as a preventative for explosions but also as a preventative of wear and the formation of carbon. Particles of ordinary dust, in heat become incandescent very quickly and will start burning gas that would not be ignited at that temperature, without the dust. Coal dust will explode at comparatively low temperatures. An air cleaner is an essential part of an air compressor, and the air cleaner must have proper care and cleaning.

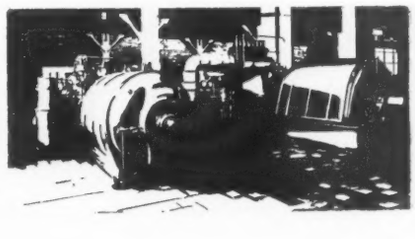
West Chester, Pa. G. B. COMFORT
Schramm, Inc.

Parallel Operation of Forward Blade Fans

IF A fan or blower were to be equipped with a stuffing box, and connected to a source of water, it would act just like a centrifugal pump. Of course it would have to be slowed down or it would fail mechanically by bending the thin blades, bursting the casing, or in some other manner.

Not only would it pump water, but the performance curves would be similar in shape to the air tests. My experience has been entirely with centrifugal pumps, but I have actually tested water pumps with air, at speeds higher than the pumps were rated for water, and got results comparable with the water performance. So it is not entirely unexpected that the same difference of opinion exists in regard to fans for parallel operation as exists in regard to centrifugal pumps.

It has been my experience, contrary to much well argued theory, that pumps with



rising characteristics can be operated successfully in parallel. This undoubtedly applies to fans also. The trouble is that the theory, although it is correct as far as it goes, does not go far enough. Furthermore, successful operation depends a great deal more on the method of control than with backward-curved vanes.

Method of operation, as pointed out by Mr. Kice, must be that each fan be controlled by a separate damper. This, I believe, is the usual thing in power-plant practice. In that case there is no reaction between the two fans, except when the dampers are wide open; then the fans are operating in the steep, and hence stable, part of the curve. At all other points, the reaction to be considered is that which exists between the two combinations of fans-and-blowers, rather than just the theoretical reaction between the fans alone, as no such reaction can really exist.

Test of a fan-and-damper combination would be entirely different from the test of the fan alone, because the static pressure connection would be made *beyond the damper*, rather than right at the discharge opening of the fan which is the usual method. It would be impossible to theorize upon the characteristic of this fan-and-damper combination because it depends entirely upon the characteristic of the duct system. For example, if tested with no duct at all, there would be no pressure at any capacity, and for this condition the static pressure curve would be merely a straight line along the capacity axis. It is because of this inter-dependence of operation that it is necessary to consider the actual set-up, and not just the fan alone.

Below the critical point, the method of operation does not matter. The curves slope downward, and there can be no hunting.

In the case of pumps, at least, the influence of the pipe line can give a great deal more trouble where the head is composed mostly of vertical rise. This never occurs in fans because the fan, stack, and other parts are submerged in the fluid they are handling. In fact, with fans handling hot flue gas, the effect of the vertical rise, or stack, would be just the opposite from the same thing in pumps, because with the stack the hot gas actually decreases the load, whereas with water, any vertical rise increases the load.

It is unnecessary to give any further details of this pipe line effect, because in the same issue of *Power* (May), there is in Mr. Kristal's article that in a pipeline without static head, Fig. 4, and having pure friction, like a fan system, the characteristic is much steeper than in his Fig. 5 where a static head is involved. This steep characteristic is highly important for stable operation, as it often determines, in the case of rising characteristics, whether the curves cross in only one point, or in more than one. Obviously when the curves cross in only one point the operation is always satisfactory, especially when they cross at a fairly large angle. Where more than one point of intersection occurs, then the question of whether or not the operation will be stable depends entirely on the control and set-up, such as the location of valves and pipelines for pumps; or in the case of fans, the ducts and dampers. In case of doubt, each case should be investigated separately. This investigation is well worth while, as pointed out in the original article by Mr. Kice, because of the advantages to be gained from forward curved vanes.

Ashville, N. C. RUSSELL K. ANNIS,
Consulting Hydraulic Engineer

Boiler Tube Leakage Caused by Scale

THE leakage mentioned in "External Corrosion Damages Boiler-Head Sheet" (May *Power*) may have resulted from several causes, but from my experience it very likely resulted from scale. A scale deposit will build up around a tube where it enters the tube sheet to such an extent as to cause overheating and leakage. Once a tube starts to leak, due to the cutting action of the leak, rolling seldom stops it unless the tube is removed and the hole reamed to a smooth surface.

We had this trouble and after failing to stop the leaks by rolling the tubes, electrically welded the tube ends. This work was done about four years ago, and the tubes are still tight. We also treat the boiler water to avoid scale formation, the original cause of the leaks.

Mechanicsville, N. Y. R. F. LEACH

Pond Cooling By Surface Evaporation

SINCE the velocity of the wind is an important factor in pond cooling by surface evaporation, data on wind velocities in different parts of the country and their seasonal variation should give additional value to Mr. Lima's article.

The accompanying map shows that wind velocities vary greatly for different parts of the country: 14 m.p.h. for the Atlantic states and as low as 4.6 m.p.h. for some Pacific states. Based on these facts, a cooling pond that might be a good investment in Texas where the mean velocity is over 10 m.p.h. may not be a paying proposition in Oregon with a mean velocity of only 4.6 m.p.h.

Fig. 5 in Mr. Lima's article gives the relation between the wind velocity and the cooling-effect factor as 1.2 for a wind velocity of 4.0 m.p.h. and 0.7 for a wind velocity of 12 m.p.h. This means that a pond of a given capacity must be twice as large in western states as in eastern states.

Another factor that must be taken into consideration is the variation of wind velocity with the season. This is shown in the table. The important difference to be noted is that while for Chicago and New York the lowest wind velocity occurs in July and August, for San Francisco it occurs in December. Assuming a given heat input, the temperature of the pond will depend on the air temperature and wind velocity. Since for San Francisco the highest air temperature and lowest wind velocity are not coincident, this is a favorable factor which partially offsets the low wind velocity prevailing in that part of the country. But in the case of Chicago and New York territories, the concurrence of lowest wind velocity and highest air temperature is an unfavorable condition which must be made up by higher investment in ponds of larger capacity.

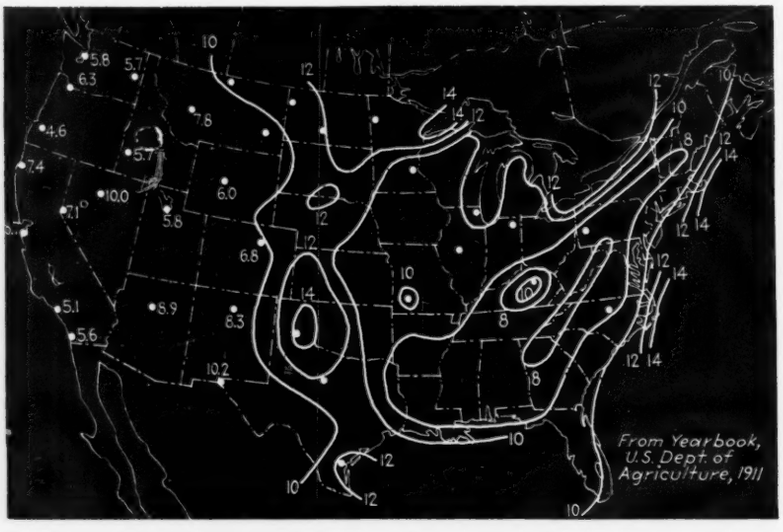
Chicago, Ill. N. T. PEF

Average Wind Velocity

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Chicago, Ill. Elev. 131 ft.....	12.5	12.1	13.3	12.7	11.2	10.3	9.6	9.6	10.2	10.9	12.2	11.9	11.0
New York, N. Y. Elev. 454 ft.....	17.4	17.1	17.9	16.6	14.3	13.5	12.6	12.4	13.0	14.7	16.3	16.7	15.2
Denver, Colo. Elev. 113 ft.....	7.6	7.6	8.2	8.4	7.7	7.3	6.9	6.6	6.7	7.0	7.2	7.2	7.4
San Francisco, Cal. Elev. 243 ft.....	6.1	6.3	7.7	7.3	8.3	8.6	8.3	7.8	6.7	6.7	5.4	5.1	7.0

Note: Elev. refers to the location of the instrument above ground. From Weather Bureau, U. S. Dept. Agriculture.

Average hourly velocity of the wind, estimated for elevation of 100 ft. over open ground



READERS' PROBLEMS

QUESTIONS for Our Readers

Improve Steam Quality

Question 1

AT PRESENT *we are using for process about 1,200 lb. of steam per hr. at 150 lb. pressure with a corresponding saturation temperature of 358 deg. We believe we can improve the quality of our product by increasing the temperature to say 425 deg., production remaining as at present. Would it be practical to obtain this temperature increase by superheating the steam to say 475 deg. and allowing it to flow through our process equipment to a small engine? What steam flow would be required for the same heat input? How much power can we expect from the engine assuming it to exhaust at atmospheric pressure?*—C.R.D.

Conduit for Motor Wires

Question 2

CAN *the primary and secondary wires between a wound-rotor induction motor and its controller be installed in the same conduit? If either practice is mandatory, why must it be used? We have had quite a lot of discussion on this problem and I would appreciate having POWER readers give us the right answer and their experience with the problem.*—R.M.

Suitable answers from readers will be paid for if space is available for publication.

Ammonia Condenser Trouble

ANSWERS to May Question 1

The Question

THE *ammonia condenser of our 15-ton direct-expansion refrigeration system has four double-pipe coils 10 pipes high. Recently ammonia was found in the cooling water leaving the condenser. Litmus paper tests showed the ammonia-contaminated water to be coming from only two of the coils. Upon closer examination one of the returns was found to be hot when the compressor was shut down and condenser cooling water was not circulating. The section was immediately shut off. After I had drawn up on all bolts at the end of the coils I opened the drain valve to the receiver. Pipe hammer developed at once and this time another return, lower down, became hot and a boiling sound could be heard. The other coil stopped leaking as soon as the bolts at the end of the coils were tightened and did not heat at any time. Will POWER readers please tell me what action caused the hammering and what caused the returns to heat?*—O.J.F.

Mixing Water and Ammonia Causes Condenser to Heat

IN ANSWER to O.J.F. will say that when anhydrous ammonia is introduced into water it will generate heat. And the faster the ammonia is introduced the more the heat, as water and ammonia have a great affinity for each other. So if he had a leak of ammonia into the water, or if the water pressure was greater than the ammonia pressure in the condenser, it would be possible for the water to get into the ammonia system. The pipe hammer was caused by vibration of the inner pipe striking the outer pipe. He had better draw off some ammonia liquid and see if it is dry. By all means repair the leaks. Put in new gaskets if needed. But they may only need a good tightening up. Check the inner pipe for leaks too. If he will take off the return bends on the water pipe he will find sludge in all pipes where the water and ammonia have come in contact, and the sludge should be cleaned out.

Parsons, Kans. B. E. RAMSEY

Boiler Tubes Leak

ANSWERS to May Question 2

THE QUESTION

WHAT *would cause the tubes of our horizontal-return-tubular boiler to leak at the rear ends? This condition is prevalent in the upper rows. We have rolled and re-rolled these tubes and even put in new ones, but trouble from leaks still persists.*—S.H.M.

Boiler Hung Improperly

LEAKY tubes in the upper and front portion of an H.R.T. boiler may be caused by one or several distinct reasons. Inasmuch as S.H.M. failed to give a general description or even a partial outline of this particular boiler, it would be impossible to definitely place the cause of the habitually leaky tubes. However, I can summarize under several headings some of the probable reasons for tubes leaking in that particular part of the boiler.

Improper boiler design: In which the upper half of the shell may be poorly stayed, such as weak or badly arranged through or gusset stays permitting unusual strain on the upper tubes. This is not an ordinary defect.

Tube holes cut or oblong make it necessary to excessively roll the tubes in order to eliminate leaks. If such is the case copper ferrules inserted around the tubes before rolling and after which the tubes are rolled and beaded, will remedy this defect. But in no case should ferrules be used unless this condition exists, inasmuch as copper causes an electrolytic action that may injure the boiler steel surrounding the copper.

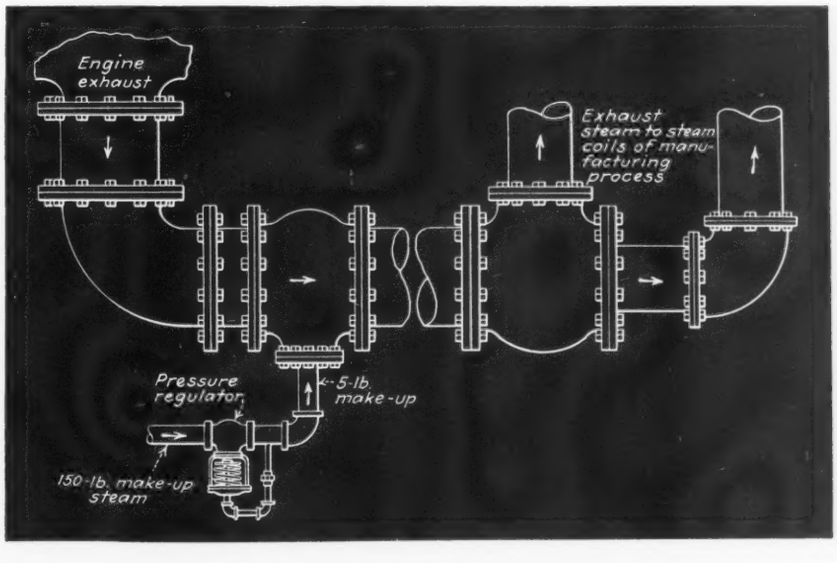
Retarded water circulation may also aid in excessive expansion and contraction and in this particular region the effect may be prominent due to the reversal of flow together with the possibility of obstructed flow due to scale on tubes or badly arranged water baffle plate.

An improperly hung boiler, resulting in strains on particular regions of the shell may

WHAT'S WRONG WITH THIS PICTURE?—V

EXHAUST STEAM PROCESS SYSTEMS

THERE are at least 13 mistakes shown in this drawing. Make a list of those you can recognize, then check against the list on page 396



play a part in tube leakage. A correct adjustment of each hanger should be made at least once a year to safeguard against misalignment.

Boiler furnace alignment and its clearance between the boiler shell proper should not be overlooked. Sufficient space should be given between boiler and refractories to permit minimum contraction and expansion. This space may be readily figured according to the size of the boiler.

A thorough check-up of these suggested causes of failure may result in S.H.M. finding the reason for this tube trouble.

Meadville, Pa. R. L. HAMILTON

Tube Leakage Caused by Overheating

TROUBLE experienced by S.H.M. will most probably be caused by one or more of the following:

1. Scale formation on rear head, thus causing overheating.
2. Oil deposit adhering to the head. This also causes overheating.
3. Localized cooling effect of comparatively cool feedwater discharging in the vicinity of rear head.
4. Cold air infiltration at rear of setting, possibly through clean-out door.
5. The tubes at rear end may not be beaded or perhaps not beaded correctly, thus causing the ends to be burned off.
6. Perhaps the rear arch in the combustion chamber is too high and should be brought down closer to the top row of tubes.
7. There is a possibility that the tubes are not rolled correctly; possibly over-rolled so that there is insufficient holding power between the tube and the head.
8. The material in the head may be inferior; although this is extremely unlikely.

I would suggest that all the above possible conditions be thoroughly checked and at the same time, it would perhaps be to your advantage if, after the tubes are correctly rolled and beaded, you ran a bead of welding around each tube end.

New York, N. Y. JOHN W. EDWARDS

Scale on Back Head

I BELIEVE the trouble that S.H.M. is having is caused by an accumulation of scale on the back head of his boiler. If this is the case, and the boiler is operated at approximately normal rating or over, the tube ends would become overheated to such an extent as to cause them to loosen up in the back head. Rerolling a tube that has been overheated is wasted energy as after the metal is burned it is rarely possible to make it tight again. I would suggest that he examine the back head and if scale is found make a chisel out of $\frac{3}{8}$ or $\frac{5}{16}$ in. round stock. The rod should be at least 48 in. long to enable him to work between the tubes vertically and horizontally. If he has enough perseverance the scale can be removed with this tool. Later the tubes should be examined carefully and those showing signs of being burned on the rear ends should be replaced with new ones.

St. Paul, Minn. E. R. WEBBER

Weld Tube Ends

I BELIEVE that S.H.M. has not given us sufficient material in his question for an intelligent and accurate answer for there are many conditions that can be held accountable for leaky boiler tubes in the location he has specified.

I believe that his trouble is either localization of heat or expansion and contraction, it being safe to assume it is not a scale or oil condition as he has already stated that even new tubes leak.

The trouble may be corrected by electric-welding the tubes to the rear tube sheet, it being understood the tubes are already beaded down. Be very sure to remove all foreign matter prior to welding to get a good clean surface, sand blasting being good to clean the sheet and tube ends. Use a covered wire and be sure you have secured a good welder. We secured the best results in the shops by having the boiler filled with water to the top of the tubes when welding. Perhaps some may frown at this idea but it worked and we were very much satisfied.

Welding is suggested because of the many cases I have seen where tube troubles were promptly corrected by this method. This is particularly so in the Economic, Empire and Double Duty types of boilers where, prior to welding the 4-in. tubes at the firebox end, we experienced much tube trouble and after welding the trouble was eliminated. We also corrected tube trouble in V.T. Boilers by welding the tubes at the upper tube sheet.

Binghamton, N. Y. C. W. CARTER, JR.

Faulty Boiler Feed

S.H.M.'s trouble is undoubtedly caused by the method of feeding the water to the boiler. The feed pipe should have perforations considerably in excess of the pipe cross section area. The end may be partly closed, and the feed pipe should act as an internal heater. Perforations should discharge the water into the body of the water and not into the steam space. Evidently S.H.M.'s feed pipe is carried too far back with a wide open end, the water being considerably cooler than the water in the boiler, or the boiler may be fed at night or week-ends with an injector which would deliver the water considerably cooler than that of the boiler. These faults would cause the rear end of the boiler at the top row of tubes to be cooler than the other parts below this row of tubes causing an unequal expansion, hence the leaky tubes.

Woodbury, N. J. R. H. CATER

WHAT'S WRONG WITH THIS PICTURE?—V

EXHAUST STEAM PROCESS SYSTEMS—SEE PAGE 395

1. *No exhaust shut-off valve.* When the engine is out of service, a shut-off valve in the exhaust connection permits closing off this line and prevents steam from any other source backing up into the engine cylinder.

2. *No atmosphere relief valve at engine exhaust.* On non-condensing engines, an atmospheric relief valve should be provided as near to the exhaust connection as possible and between the engine and the exhaust shut-off valve. Failure to provide such a valve, correctly adjusted, might cause a dangerously high pressure to build up if the engine were started with a closed exhaust shut-off valve.

3. *No by-pass around pressure reducing valve.* Failure to provide a by-pass around this valve would prevent use of make-up steam in case of a defective regulator.

4. *No shut-off valves in pressure reducing valve connections.* It would be impossible to make many repairs to the regulator without cutting the pressure off of the whole system unless shut-off valves are installed on both sides of the reducing valve.

5. *No shut-off valve in diaphragm connection of pressure reducing valve.* A ruptured diaphragm cannot be replaced unless pressure is shut off in this line.

6. *Diaphragm connection piped to wrong place.* The diaphragm connecting pipe should go to the main exhaust line to control the pressure accurately.

7. *No relief valve following the pressure reducing valve.* In case the regulator sticks open, a dangerously high pressure might build up in the low-pressure system. There are but few instances where a relief valve should not follow a pressure reducing valve. The relief valve should not be less than about 75% of the diameter of the steam line, and it should be set at not over the maximum allowable pressure on the system which it protects.

8. *No drain in exhaust system.* A drain should be provided at the lowest part of the exhaust line, and near the engine, to prevent condensate from collecting. A drain should also be provided at the high-pressure side of the reducing valve. All drains should be connected to traps.

9. *Make-up connected at wrong place.* Make-up should connect to side or top of header. Bottom connection provides a pocket in which condensate may collect and cause a water hammer when reducing valve opens.

10. *Expansion Joint.* The exhaust line should be connected to the engine through an expansion joint or the piping designed so that no expansion strain will be exerted against the engine.

11. *No stop valves at branch connections.* Each branch from the exhaust header should be provided with a gate stop valve so that steam to each branch can be shut down for repair without having to shut down the entire system. Drains should be provided at the discharge side of these valves.

12. *No support for header.* Header supports should be provided that will permit its movement due to expansion.

13. *No oil separator.* Where the exhaust steam condensate of a reciprocating engine is to be used for boiler feed purposes, some efficient means of removing oil should be provided.

New York, N. Y. HARRY M. SPRING

FIRM CAPACITY RATINGS

A means to keep down investment for added capacity until needed, as presented in a paper before the Edison Electric Institute convention at St. Louis

By M. S. Dean

Chief Assistant Electrical Supt
Detroit Edison Co.

IT HAS been said that operating an electrical system consists mainly of taking chances intelligently. This certainly applies to the loading of it, particularly when it is considered that the maximum safe loading in any particular situation turns so largely on what emergency ratings one may count upon with a part of the equipment out of commission for repairs. Unfortunately there is often little agreement as to emergency ratings and not infreqeuntly a dearth of knowledge. However, the problem is here and must be faced and where accurate knowledge is not available, intelligent approximation must be relied upon.

Intelligent taking of chances is also highly important in the field of system design. A system built to be foolproof and to guard against every conceivable contingency is not only unreasonable from a cost point of view, but is likely, if expanded indefinitely, to become unwieldy from sheer mass of detail and from operating complication. The clever system designer will fortify himself with a background of actual operating performance to insure that in setting his emergency conditions he will be spending money to guard against actualities and not against situations which rarely, if ever, occur.

In considering the loading which may reasonably be imposed in any situation, the number of factors to be considered is rather large and it is difficult to keep these in mind and to give to each its due importance.

To aid in evaluating these factors, the method of firm rating has been devised. In any particular situation the firm rating may be defined as the amount to which the load may be increased before additional load carrying capacity must be provided. Its determination implies a thorough knowledge of load and system conditions and an understanding of the overload ratings of the various equipments which comprise the system. In the field of generating capacity the firm rating idea works about as follows:

Assume a system having a single generating plant and few enough generating units so that their maintenace can be safely carried out in the off-peak season, thereby assuring that all units will be available during the peak season. If now we assume the largest unit to be out of commission due to an emergency, the firm rating of a steam plant will be the maximum overload rating of the remaining machines as determined by boiler conditions, cooling water temperatures, and generator limitations; and that of a hydraulic plant will be determined by stream flow and storage conditions.

It is usually necessary to test the various generating units from time to time to determine their actual overload ratings under the particular conditions. One is justified in assuming for emergency purposes the maximum overload ratings because load estimates made a year in advance are usually liberal and peak loads are encountered on only a few days per year and usually persist only a few hours.

Where a generating system consists of several plants interconnected by inter-plant tie lines and the number of generating units becomes large, it becomes difficult to complete all maintenance work during the off-peak season. It may, therefore, be advisable to assume that one or possibly two units are out of service for maintenance work at the time of system peak and that another fails at that time and further, that two units may be out of service in the same plant. The firm rating of each plant then becomes the sum of overload ratings of its remaining units plus the help which the inter-plant tie lines can bring in from the remainder of the system, including interconnections. The rating of the remainder of the system can, under such conditions, be considered as equal to the sum of the overload ratings of all its units unless there are some inter-plant tie line limitations.

Considering the generating plants from the design point of view, it is evident from the above that since the assumed emergency condition is based on a given number of the largest generators being out of commission, the size of the generating units chosen is an important consideration in determining the firm rating of system or plant. If they are large in proportion to the system, then the firm rating will be a smaller percentage of the nameplate rating than if the generators were smaller. On the other hand, the cost per nameplate kilowatt of generating capacity increases as the size of the generators decreases.

There are therefore two conflicting tendencies which are not easy to evaluate. If it is remembered that the purpose is to carry the load at the minimum cost, it becomes evident that the criterion is the cost per kilowatt of firm rating. In general, therefore, that generating system is best developed in which the generating unit sizes are so chosen as to give, over a period of years, the lowest cost per kilowatt of firm rating.

In the field of transmission and substations the method of firm ratings is also readily applicable and useful.

If the largest unit be a transformer bank, the safe overload rating of the remaining transformers is the limiting case. Here a careful study of typical daily load cycles to determine the duration of peak loads and to take maximum advantage of the infrequency of peak load days as well as a study of the season during which the peak loads may occur and the probable ambient temperatures will often pay excellent dividends in firm ratings by insuring the maximum allowable emergency rating of the transformers. Overload ratings on straight self-cooled or water-cooled transformers will range from 10 to 25% and on self-cooled, with emergency air-blast or water-cooling, 30 to 50%.

If the limiting case is the loss of inter-station ties, the limit may again be voltage regulation, or if they be cable ties it may be the thermal limit of the cables. If the thermal limit applies, again a thorough study of maximum one day ratings pays excellent returns. Cables and duct banks can safely carry surprisingly large loads for a few hours on an occasional peak day, particularly in the cooler seasons, as is set forth in the paper of which the foregoing is an abstract.

TABLE II — TYPICAL EMERGENCY OVERLOAD CYCLES FOR A DISTRIBUTION SUBSTATION STEPDOWN TRANSFORMER

6,000-Kva. Transformer, Three-phase, Self-cooled

Emergency Load—Once a year without material injury

30 Deg. C. Ambient

Industrial Load	Residential Load
3,850 kva.—16 hours	2,750 kva.— 9 hours
7,700 kva.— 8 hours	4,950 kva.—11 hours
	8,250 kva.— 4 hours

40 Deg. C. Ambient

Industrial Load	Residential Load
3,500 kva.—16 hours	2,500 kva.— 9 hours
7,000 kva.— 8 hours	4,500 kva.—11 hours
	7,500 kva.— 4 hours

Residential Load—Overload without exceeding guaranteed temperature

10 Deg. C. Ambient

6,000 kva.—20 hours
9,000 kva.— 4 hours

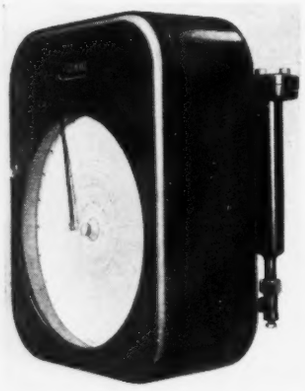
TABLE I—FIRM RATING (IN MEGAWATTS) OF TYPICAL GENERATING PLANT AND SYSTEM, WINTER OR SPRING CONDITION

Generating Plant	Boilers: Total No.	Boilers: Number *Firm	Boilers: Firm Rating	Generator Ratings: Name Plate	Generator Ratings: Maximum	Generator Ratings: Maximum Less Two	†Total Tie Line Rating	Plant Max. Rating	Plant Firm Rating	System‡ Firm Rating
A.....	5	4	*153*	160	172	64	60	153	124	744
B.....	13	11	*300*	300	325	215	75	300	290	748
C.....	12	10	200	180	*190*	100	70	190	170	743
D.....	8	7	*165*	160	169	85	70	165	155	753
Interconnections	..	..	...	25	25	...	..	25	25	...
Totals.....				825				833		

‡System nameplate rating 825 MW. Minimum system firm rating, 743 MW. Minimum system reserve, 82 MW. (10%).

*Assumes normal boiler maintenance. †One day maximum tie line ratings. ‡Assumes two machines out at the plant in question, and all other plants at plant maximum.

WHAT'S NEW IN PLANT EQUIPMENT



ORIFICE METER

FLOW through orifice, flow nozzle or venturi tube, sets up differential pressure which is piped to U-tube manometer and measured in terms of rate of flow in this orifice meter for temperatures and pressures. Features include direct-reading integrator, 12-in. diam. chart, spring or electric clock drive, interchangeable manometer tubes to change capacity, removable cover plates and forged-steel float chamber. Flush panel or rear mounting. Meter bodies for from 1 to 200 in. of water.

Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia, Pa.

THIN-WALL TRANSITE CONDUIT

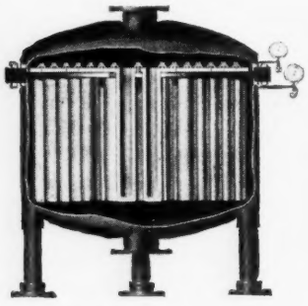
"TRANSITE KORDUCT," asbestos-cement product, is formed under high pressure on polished-steel mandrel for smooth interior. Thin-walled form, for duct system inclosed in concrete. Said to be rot-proof, incombustible, immune to electrolysis and corrosion and have high-heat dissipation rate.

Johns-Manville Corp., 22 East 40th St., New York, N. Y.

LIGHT-DUTY FREIGHT ELEVATOR

EXTERNAL geared, traction elevator machine for light freight has large diameter, extended, worm shaft which carries motor armature and brake pulley. Pressure-lubricated ball bearings carry shaft and take end thrust. Semi-steel, one-piece, external gear is on machine beam and protected by gear guard (not shown).

Otis Elevator Co., 260 Eleventh Ave., New York, N. Y.



POROUS-STONE FEEDWATER FILTER

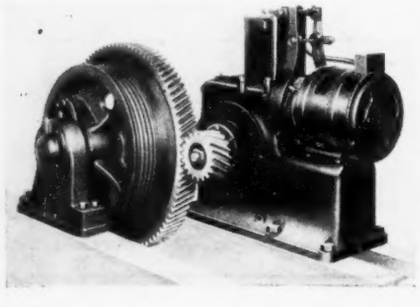
MULTIPLE arrangement of porous filter tubes is suspended from tube sheets within steel shells in filter for boiler feedwater. Water enters through bottom, passes through walls of tubes and emerges through top nozzle. Pressure gages and sampling cocks on either side of tube sheet indicate differential across tubes. Chemical feed consists of 3-gal. cast iron alum container, sight-feed valve and proportionate differential feed.

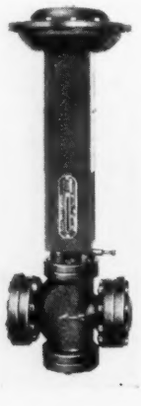
R. P. Adams Co., 220 Delaware Ave., Buffalo, N. Y.

DIAPHRAGM VALVE-MOTOR

"MOTOSTEEL" improved, welded-steel diaphragm valve-motor has larger molded diaphragm, formed impressions in top plate for access of air pressure to diaphragm in starting, and longer and larger diameter spring for greater initial compression and less hysteresis. Removable side plates provide access to spring and adjusting nut.

Taylor Instrument Co., Rochester, N. Y.





WASTE-LINE CLEANER

"POWER-TWIST" waste line cleaner consists of flexible steel rod wound on reel and fed through sleeve and flexible nozzle. By setting ratchet pawls on sleeve, rod is fed into waste line with pumping motion. When filling, or stoppage is encountered, slight tension is put on rod. Reel is then twisted (swiveled at handle grip and sleeve). Reaches stoppage 50 ft. from opening in 1 in. and larger lines.

Standard Appliance Corp., 201 Hickory St., Dayton, Ohio.

SELF-ALIGNING LOCK BEARING

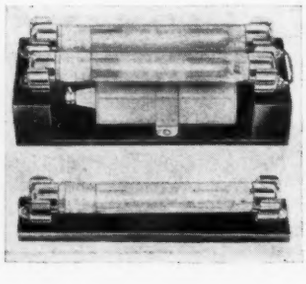
GRIP-LOCK, self-aligning, extended inner race bearing has spring-steel locking shoe in eccentric groove machined in bore of inner race. Bearing is slipped on shaft when shoe is in deepest part of groove. Holding inner race of bearing while shaft turns allows knurling at ends of shoe to grip shaft, wedging shoe in shallow part of groove and locking bearing.

SKF Industries, Inc., Front St. & Erie Ave., Philadelphia, Pa.

SURGE PROTECTORS AND ARC SUPPRESSORS

NO CURRENT flows in gaseous discharge tubes until voltage is sufficient to ionize gas in electronic surge protectors and arc suppressors. For surge protection, tube rated at 125, 250 or 500 volts d.c. is shunted across coil or magnet between switch and coil and reduces potential to normal in 0.010 to 0.1125 sec. after opening circuit. Junior line has 10-amp. current-carrying capacity, heavy-duty line 100 amp. Arc suppressor reduces voltage rating of condenser needed across switch points. Also used as lightning arrestor and for bypassing transients. Bulletin.

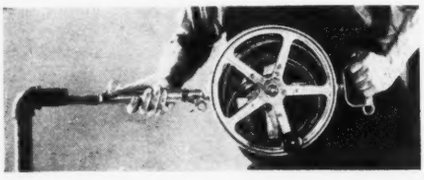
Sundt Engrg. Co., 4238 Lincoln Ave., Chicago, Ill.



INDUCTION MOTOR LINE STARTER

DE-ION line starter for across-the-line starting of single and polyphase squirrel-cage induction motors may be used as primary switches for wound-rotor induction motors. Thermostat disk overload relay has inverse time characteristic to prevent shut down from temporary overload. Contactor assembly removed by loosening screw which clamps steel base against rubber pads.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



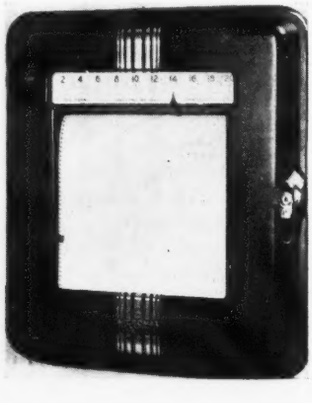
PORTABLE 20-TON HYDRAULIC JACK

"PORTO-POWER" 20-ton hydraulic jack consists of pump and ram separated by 8-ft. flexible hose to operate in any direction. Collapsed height of 10¼ in. plus 4½ in. plunger travel and 3¾-in. screw extension gives overall height of 18 in. 4-in. overall diameter. Threaded base for mounting and for heavy extension. Bulletin 268.

Blackhawk Mfg. Co., Milwaukee, Wis.

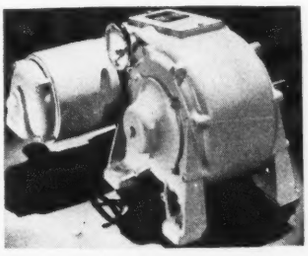
INDICATING AND RECORDING CONTROLLER

"SILVER ANNIVERSARY" Micromax recorder provides all combinations of indicating, recording, signalling and controlling. Pointer



for instantaneous readings, while 10 in. of strip chart show condition for past several hours. On controllers, second pointer shows control setting. Parts accessible by means of double frame. Catalogue N-33A.

Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.



VARIABLE-SPEED POWER UNIT

SPEED-TROL, inclosed, infinitely variable-speed transmission unit and motor for from ¾ to 15 hp. has medium-width V-belt running on alloy-iron pulleys on parallel shafts. Handwheel changes diameter of both pulleys through chains and sprockets. Single or multiple reduction. Unit available for any mounting with all types of motors and remote and automatic controls.

Sterling Electric Motors, Inc., Telegraph Rd. at Atlantic Blvd., Los Angeles, Calif.

BELT PULLEY BANDAGES

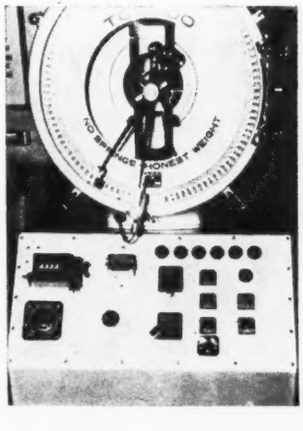
"CONTRASIT" belt-pulley bandage permits operation with slack belts, eliminates resin and insures even pull. For wood, iron, steel and leather, stepped-cone and common pulleys. American agents:

Scann-American Sales Service, 200 Broadway, New York, N. Y.

REMOTE CONTROL WEIGHING MACHINE

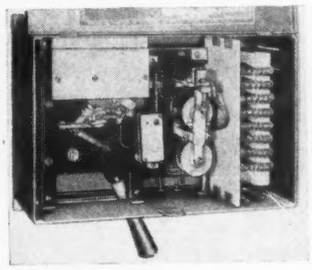
COMPLETE remote control, indication and recording of weighing process is provided by this automatic system. Pulverized coal is fed to conveyor on special systems of levers. Dial or lever system actuates remote indicating dial and totalizing device for each boiler. Drop in coal supply indicated on remote dial and automatically reduces air supply in proportion.

Toledo Scale Co., Toledo, Ohio.



DIRECT CURRENT MOTOR STARTER

TYPE DRT automatic motor starter for shunt or compound-wound, 250 to 600 volt, d.c.



motors, has resistance element of continuous wire wound on asbestos form. Chrome-plated latch rollers, latches and steel pins on circuit breaker. Relay starts motor on resistance which is cut out when motor gets up to speed. Circuit breaker set for 25% overloads for 3 min.

Ohio Brass Co., Mansfield, Ohio.

FOUNTAIN-PEN OILER

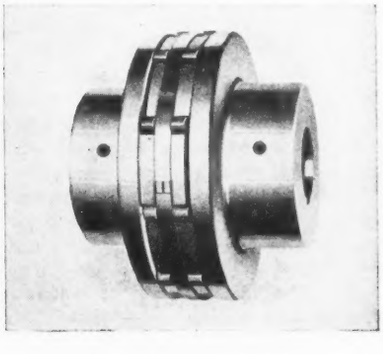
TRANSPARENT non-breakable reservoir has no-leak refill screw cap, pocket clip and spout similar to fountain pen. Brass tip and cap are chromium plated. Steel point attached to plunger ejects 1/10 drop each stroke.

V. R. Hall Products Co., 9304 Amesbury Ave., Cleveland, Ohio.

HEAVY-DUTY FLEXIBLE COUPLING

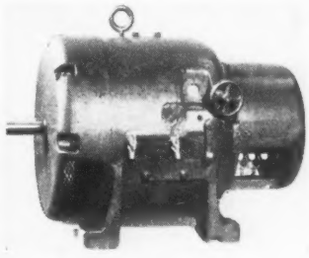
TYPE W non-lubricated, heavy-duty, flexible coupling has individual load cushions free floating between metal jaws and secured by spiral steel spring. No metal-to-metal contact. Three cushioning materials, brake-lining, leather and rubber duck fabric. Bores from 3 to 14 in. diam. for 18 to 2,000 hp. at 100 r.p.m.

Lovejoy Tool Works, 5019 West Lake St., Chicago, Ill.



BELTED OR COUPLED WELDING GENERATOR

CROSS-FIELD principle eliminates rheostat, resistors, meter, reactor and exciter usually required. Mechanical control of welding current obtained through control of armature reaction fluxes. Switch changes polarity of elec-



trode without changing cable connections. Drip-proof shell and two ball bearings. 200-, 300- and 400-amp. units give currents from 60 to 500 amps.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

HIGH-TEMPERATURE STEEL

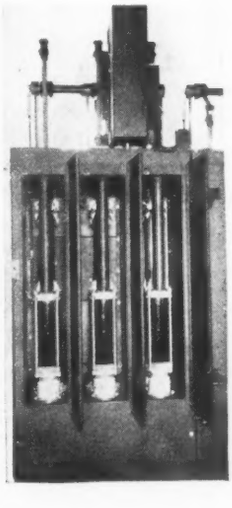
"SILMO" steel for application where high-temperature strength and oxidation resistance are required has about twice strength of carbon steel and oxidation resistance near 4-6% Cr-Mo steel between 1,000 to 1,200 deg. F. Complete technical data in 6 looseleaf pages.

Timken Steel & Tube Co., Canton, Ohio.

STEEL CUBICLES FOR CIRCUIT BREAKER

STEEL cubicles for Type FH oil circuit breakers to replace masonry cells and bus structures feature simplicity of installation and high salvage value should location be changed. Shipped completely assembled to minimize field work. Mechanical and electrical interlocks available.

General Electric Co., Schenectady, N. Y.



TEMPERATURE AND PRESSURE INDICATING CONTROLLER

"TALSCOPE" Air-operated indicating controller with high-range or full-range sensitivity for short and long-time lags, adjustable control point and reversible action, is available with control ranges from —100 to 1,200 deg. F. and 0 to 2,000 lb. abs. Temperature controller equipped with mercury-, vapor- or gas-actuated tube systems. Catalog 86 R.

Taylor Instrument Co., Rochester, N. Y.

CHEMICAL, SOOT AND SLAG DESTROYER

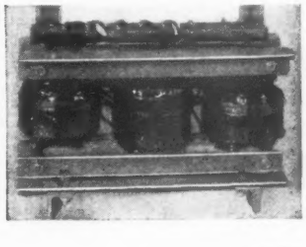
"OXI," dry crystalline composition creates oxygen when thrown into furnace while operating. Oxygen is said to burn combustible matter in soot, carbon scale and slag, reducing them to ash. For water- and fire-tube boilers. Use 1 lb. for 250 sq.ft. per day.

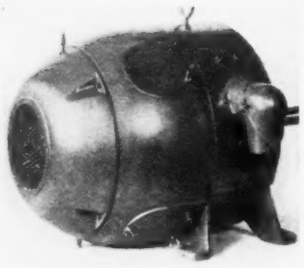
Walters Mfg. Co., Inc., 51 East 42nd St., New York, N. Y.

SEMI-PORTABLE PHASE TRANSFORMER

FOR operating standard equipment on varying power supplies, this semi-portable, air-cooled, transformer features ease of handling and installation. Active parts are attached to steel angles and inclosed in ventilated steel case (not shown). Regularly supplied with terminals for 220, 440 and 550 volts, 3-phase, 60 cycles. Special transformers if 2-phase or other voltages are desired. Transformer will change 220 to 440 and 550 volts, 440 to 220 and 550 volts, 550 to 220 and 440 volts, without alteration. Standard sizes from 1 to 50 kva.

Forbes & Myers, 172 Union St., Worcester, Mass.





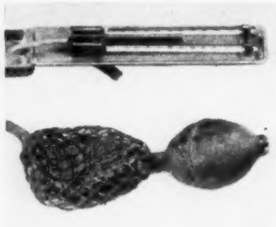
FAN-COOLED, INCLOSED D.C. MOTOR

TYPE SK 5- to 75-hp. motors for 115, 230 and 550 volts d.c. has interior protected against splashing water and removable bracket covers. Pulley or pinion may be mounted close to bearing and motor may be close to wall without interfering with ventilating air.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

HAND-ASPIRATED PSYCHROMETER

WET- and dry-bulb thermometers similar to those in plain psychrometers, but arranged so aspiration over bulbs is induced by air from hand pump. Gentle pumping on hand pump inflates flexible reservoir, protected against over-inflation by net covering, which evens out impulses of hand pumping and provides steady supply of air to nozzle inside Venturi tube. Jet of air in Venturi tube induces larger supply of air to be drawn through chamber which surrounds wet



and dry bulbs. Handle forms case when not in use, giving closed over-all length of 7½ x 1½ x ¾ in., and weight of 12 oz.

Julien P. Friez & Sons, Inc., Baltimore, Md.

ELECTRIC HOIST

"ZIP-LIFTS," with capacity ratings from 250 to 500 lb., for "spot handling" work. Welded construction, ¼-ton model weighing 100 lb. Ball-bearing motor operates through planetary gear train fully inclosed and running in oil. Hoisting speeds up to 32 ft. per min. Controlled by pushbutton or pendant rope. Weight-type limit switch, solenoid dry disk motor brake and ratchet and roller type mechanical brake. With or without trolley.

Harnischfeger Corp., Milwaukee, Wis.

WELDING TORCH

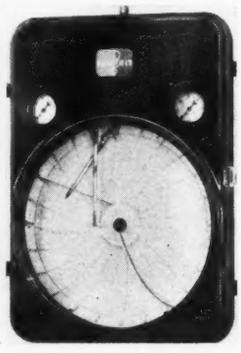
LIGHT-WEIGHT welding torch weighing only 17½ ounces with tip, uses new alloy which can be forged, extruded and heat treated and has tensile strength of mild steel. Fluted wheel handles have spring tension to hold adjustments. Standard and Super types.

Modern Engrg. Co., 3411 Pine St., St. Louis, Mo.

PNEUMATIC RECORDER-CONTROLLER

"AMPLISET" free-vane controller for temperature, flow, liquid level, pressure and humidity has adjustable sensitivity to fit process lag. Can be changed from direct- to reverse-acting or vice versa. Bulletin No. 440.

Bristol Co., Waterbury, Conn.



BOILER-WATER DENSITY METER

DENSIMETER, small floating glass bulb, sinks to bottom when placed in beaker of warm boiler water. Water is stirred with thermometer graduated in grains per gallon (from 25 to 500) until water cools to point where bulb floats. Concentration is then read on thermometer. Bulb is in metal carrying-case and thermometer has pocket clip.

National Aluminate Corp., 6216 West 66th Place, Chicago, Ill.

THE ENGINEER'S BOOKSHELF

Thermodynamics

THERMODYNAMICS FOR ENGINEERS (2nd Edition)—*By Sir J. A. Ewing. Published at Cambridge at the University Press, New York, by the Macmillan Co. 389 pages, 6x9 in. 100 drawings and an appendix including tables on properties of steam. Price $6.*

Sir Alfred was just completing revision of this 16-year old standard text at the time of his death, so the chapter on radiation he had planned was never written. Otherwise, however, the text is in accord with latest practice in theory and in nomenclature and with most recent International Steam Table Conference Values. The Centigrade scale is used throughout because Sir Alfred felt the Fahrenheit scale is inconvenient to use. Approach is still as it was in the original edition, first elementary notions and their practical application, then the mathematical treatment. This makes it simple and easy to understand for both the mathematician and the non-mathematical-minded reader.

Standards

AMERICAN STANDARDS FOR ROTATING ELECTRICAL MACHINERY (1936). *Published by American Standards Association, 29 W. 39th St., New York, N. Y. 100 pages; 8 x 10½ in.; paper. Many diagrams, charts and tables. Price $1.30.*—Standard requirements and specifications for rotating electrical machinery including direct current, synchronous and induction machines, synchronous converters and a-c and d-c fractional horsepower motors. Combines new material of A.S.A., material formerly published by A.I.E.E. and motor and generator standards of N.E.M.A.

Electrician's Handbook

AMERICAN ELECTRICIAN'S HANDBOOK (*4th Edition*)—*By Terrell Croft. Revised by Clifford C. Carr. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 1,051 pages, 4 x 6½ in. Semi-flexible binding. Many illustrations and tables. Price, $4.*

A practical handbook on the installation and care of electric wiring and equipment like this one retains its usefulness only in proportion to how closely it represents practices established by the standard codes. It was to make the text conform with the many changes in the 1935 National Electrical Code that the fourth revision has been made. Each of the six divisions has been revised and more than 200 pages of new material added.

The first division of the book deals with fundamentals, measurements, splicing, batteries, and circuit calculation. Generators and motors, their installation, operation and maintenance comprise the second division. Outside wiring, interior wiring, transformers and electric lighting each is the subject for a division. The treatment throughout is practical, and the many tables and illustrations add much to the book's usefulness.

Workshop Receipts

WORKSHOP RECEIPTS (5 vols.)—*American distributors, Chemical Publishing Co. of N. Y., Inc., 148 Lafayette St., New York, N. Y. Over 500 5½x8-in. pages per volume. Cloth. Many illustrations. Price $2.50 per volume.*

No one can be a specialist in every field. But there almost always comes a time when one wishes he were. These books are planned to fill that need when it is for a formula, process, "kink," "trade secret," or any of the innumerable other little pointers that are so hard to find when you need them. A standard English book, it has not been sold in this country previously. It is compiled alphabetically, so power references are distributed throughout the four volumes and the supplement. Included are such subjects as ball valves, belting, boiler corrosion, boiler compositions, boiler and pipe coverings, briquette fuels, "chimneys," in the first volume, with

similar subjects in the others. The supplement goes from A to Z on present-day information, so is the preferable book for general use if you want but one. It includes some data on bearings, centrifugal pumps, grease guns, oil, small power plants, refractories, refrigeration, torque converters, water softening and welding.

BRIEF REVIEWS

SMOKELESS BRIQUETS: Impacted Without Binder From Partially Volatilized Illinois Coals; II (1936). *By R. J. Piersol. Published by Illinois State Geological Survey, Urbana, Ill. Price 25 cents (one copy free to Illinois residents and libraries for postage of 8 cents until Aug. 1, 1936).*—Report of investigation 41 giving a quantitative measurement of smoke.

A.S.T.M. PAPERS (1936). *Published by American Society for Testing Materials, 260 South Broad St., Philadelphia, Pa. Preprints of two papers presented at 39th annual meeting in Atlantic City, N. J., June 29-July 3.* EFFECT OF SOLUTION COMPOSITION ON THE FAILURE OF BOILER STEEL UNDER STATIC STRESS AT 250°C, *by W. C. Shroeder, A. A. Berk, and Everett P. Partridge. 30 pages, 6x9 in.; many tables and photos.* REPORT OF COMMITTEE C-8 ON REFRACTORIES. *10 pages; 6x9 in.; paper; one table. Both free.*

SYMPOSIUM ON INDUSTRIAL FUELS (1936). *Published by American Society for Testing Materials, 260 So. Broad St., Philadelphia, Pa. 70 pages, 6 x 9 in.; paper. Many tables and charts. Price 75 cents, 60 cents each for 10 or more.*—Contains four technical papers on coal and coke, industrial fuel oils, manufactured gas and liquefied petroleum gas. By A. C. Fieldner, chief engineer, Experiment Stations Division, U. S. Bureau of Mines, and W. A. Selvig, supervising chemist, Miscellaneous Analysis Section, Pittsburgh Experiment Station, U. S. Bureau of Mines; H. V. Hume, combustion engineer, Atlantic Refining Co., P. T. Dashiell, vice-president, and F. H. Trembly, Jr., assistant sales manager, Philadelphia Gas Works Co.; and W. H. Bateman, president, Solgas, Inc.

PUBLIC OWNERSHIP, PROMISES AND RESULTS (1936). *By Howell Wright, 440 The Leader Bldg., Cleveland, Ohio. 81 pages; 6x9 in.; paper; many tables. No price given.* —Story of building and operation of Oberlin, Ohio, municipal light and power plant.

OUTLINE OF STEEL AND IRON (1936). *By Archibald Allison. Published by H. F. and G. Witherby, Ltd., 326 High Holborn, London, W.C.1. 192 pages; 5½x8 in. Cloth. 21 illustrations. Price 6s., net.*—Of necessity a very brief outline of the history and manufacture of iron and steel. Written primarily for the layman or inquiring amateur and possibly for students. Very fine historical sections but rather weak on details of modern-day practice.

ATLANTIC DRAINAGE (1936). *Published by Dominion Water Power and Hydrometric Bureau, Dept. of Interior, Ottawa, Canada, as Water Resources Paper No. 73. 94 pages; 6½ x 9¾ in. Paper. Mostly tabular. Free.*—Results of investigations made by Dominion Hydrometric Survey during the climatic years Oct. 1, 1930, to Sept. 30, 1932, in provinces of New Brunswick, Nova Scotia and Prince Edward Island: 75 pages of stream flow data covering principal rivers and streams in three provinces with precipitation records for number of stations.

CAUSE AND PREVENTION OF STEAM TURBINE BLADE DEPOSITS (1936). *By Frederick G. Straub. Published as Bulletin No. 282, Engineering Experiment Station, University of Illinois, Urbana, Ill. 50 pages; 6x9 in.; paper; 13 tables and 18 figures. Free until Nov. 15, thereafter 55 cents.*—Report of an investigation by Engineering Experiment Station in cooperation with Utilities Research Commission, Inc.

PROCEEDINGS OF INDUSTRIAL FUELS CONFERENCE (1936). *Published by Dept. of Smoke Regulation, Hudson County, N. J. 16 mimeographed pages; paper. Free.*— Minutes of Industrial Fuels Conference held at Court House, Jersey City, N. J., March 27, 1936.

ARCTIC AND WESTERN HUDSON BAY DRAINAGE (1936). *Published by Dominion Water Power and Hydrometric Bureau, Dept. of the Interior, Ottawa, Canada, as Water Resources Paper No. 68. 390 pages, 6½ x 9¾ in. Mostly tabular. Free.*—Results of investigations made by Dominion Hydrometric Survey during climatic years Oct. 1, 1929 to Sept. 30, 1931, in provinces of Alberta, Saskatchewan, Manitoba and western Ontario: 368 pages of stream flow data covering principal rivers and streams with records of meteorological stations at Keewatin, Ontario and Pinawa, Manitoba.

EFFECT OF VARIOUS OPERATING CONDITIONS UPON ELECTRICAL BRUSH WEAR AND CONTACT DROP (1936). *By Victor P. Hessler. Published as Bulletin No. 122 by Iowa Engineering Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa. 72 pages, 6x9 in., 6 illustrations, 55 graphs, 15 tables. No price given.*

THE CONSTRUCTION INDUSTRY, Including a List of Selected Trade Associations (1936). *Published by U. S. Dept. of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C. 123 pages, 37 charts, tables and maps. Price, 10 cents, with 25% discount on orders for 100 or more. (Stamps not accepted.)*—Report presents a coordinated picture of all construction activities in U. S. Includes directory of about 600 trade associations in general field and more than 100 publishers of books and periodicals pertaining to building industries.

SCIENTIFIC REFRIGERATION IN RELATION TO NUTRITION AND HEALTH (1936). *By Lulu G. Graves. Published by Temperature Research Foundation of Kelvinator Corp., 420 Lexington Ave., New York, N. Y. 16 pages; 7x10 in.; paper. Free.*

HYDRAULIC AND ROAD QUESTIONS IN CHINA (1936). *Published by the League of Nations, distributed by World Peace Foundation, 8 West 40th St., New York, N. Y., 214 pages, 8 x 10½ in. Paper. Many tables, charts and diagrams. Price $1.75.*—Report by group of experts appointed by the League Transit and Communications Organizations, as requested by Chinese government, for opinion on problems regarding water conservation and road construction and transport. Solutions and work necessary for accomplishment, set out in plans, drawings and explanatory tables.

REGULATIONS OF AIR HYGIENE FOUNDATION OF AMERICA, INC. (1936). *Published by Air Hygiene Foundation of America, Inc., Pittsburgh, Pa., as Information Circular No. 1. 12 pages, 3½x9 in. No price given.*— Constitution and by-laws of recently-formed organization.

COAL, DETAILED STATISTICS (1936). *By W. H. Young, L. Mann, H. L. Bennit, and F. G. Tryon. Published by U. S. Dept. of Interior, Bureau of Mines. 84 pages; 6x9 in.; paper. Almost completely tabular. Price 5 cents from Superintendent of Documents, Washington, D. C.*—Statistical appendix to Minerals Yearbook of 1935.

NEW BULLETINS

Electric Boilers—Commonwealth Electric & Mfg. Co., 83-105 Boston St., Boston, Mass. Single sheet on electric heated, full-automatic, steam boilers for 30 to 252 kw., with pressures from 0 to 300 lb.

Water Columns—Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, Ohio. 8-page catalog folder on float-operated safety water columns includes specifications and prices.

Motors—Reliance Electric & Engrg. Co., Ivanhoe Road, Cleveland, Ohio. 4-page Bulletin 117 on Type AW, wound-rotor motors for 2- and 3-phase a.c. Bulletins 213 and 214 on enclosed, fan-cooled, Type T, d.c. motors. 215 and 216 on 6-pole, Type T, d.c. motors.

Chains — Columbus-McKennon Chain Corp., Tonawanda, N. Y. Catalog, Issue No. 7, on welded and weldless steel chains.

Variable Speed—Reeves Pulley Co., Columbus, Ind. Booklet and Engineering Tables give design, operation and prices on "Vari-Speed Motordrive."

Plastic Fire Brick—Mexico Refractories Co., Mexico, Mo. 10-page bulletin describes and illustrates applications of plastic, monolithic, fire brick.

Paint Products—Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa. 32-page booklet No. 2562 discusses "Science of Seeing," "Cost of Lighting," and effects of paint.

Instruments — Brown Instrument Co., Wayne & Roberts Ave., Philadelphia, Pa. 24-page, well illustrated, silver and black booklet presents study of instruments from executive's viewpoint.

Instruments and Control—Brown Instrument Co., Wayne & Roberts Ave., Philadelphia, Pa. 8-page folder on potentiometer pyrometers and other instruments.

Valves—W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa. 4-page Bulletin No. 236 on 2, 3 and 4-way, balanced, flat-disk, hydraulic valves.

Humidifying Equipment — Spray Engrg. Co., 114 Central St., Somerville, Mass. 4-page bulletin illustrates humidifying equipment for industrial plants.

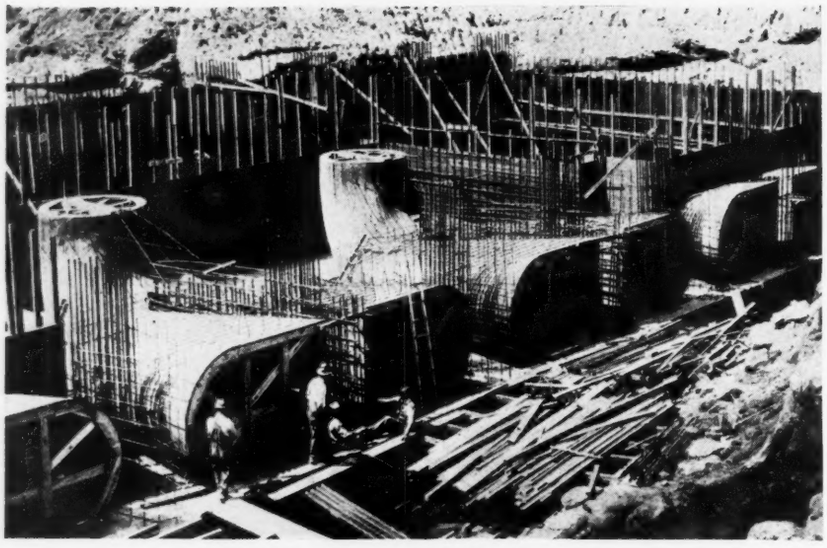
Spray Nozzles—Spray Engrg. Co., 114 Central St., Somerville, Mass. 22-page illustrated catalog of spray nozzles for industrial purposes.

Pneumatic Sponge—Byron Jackson Co., Berkley, Calif. 4-page, illustrated Bulletin No. 360-C on rotary, air-motor driven centrifugal pump for 50- to 150-ft. heads.

Piston Pumps — Worthington Pump & Machinery Corp., Harrison, N. J. Two 4-page bulletins on valve-plate type, horizontal, single-piston pumps. Bulletin W-111-B8 on Type AC for up to 250 lb. per sq.in., and W-111-B9 on Type AA for up to 75 lb.

Compressors — Ingersoll-Rand Co., 11 Broadway, New York, N. Y. 28-page catalog 7502-E, covers "Type 30" line of industrial compressors and vacuum pumps.

Force Feed Lubricators — Manzel Bros. Co., Buffalo, N. Y. 12-page, illustrated, catalog No. 25-B, on Model "25" force-feed lubricator.



POWER AND WATER FOR NEBRASKA

Placing forms for draft tubes of the $7,200,000 PWA North Platte power and irrigation project. Water from the North Platte River is carried over a divide, then under the South Platte River into a reservoir through a siphon. Of four 17,500-hp. turbines provided for in the power house, two are being installed to operate under a 200-ft. head

POWER LINES

Arrange Tours For Conference Delegates

Four study tours are being arranged for foreign delegates to the Third World Power Conference and Second Congress on Large Dams, to be held in Washington, D. C., Sept. 7-12, 1936. These will cover (1) Mineral Sources of Energy, (2) Hydraulic Sources of Energy, (3) Power Transmission and Distribution and (4) Railway Transport, Diesel, Steam and Electric.

Chicago Chiefs Exchange Experience

CHICAGO engineers have an organization which may put a good idea into the heads of others elsewhere. This is the Chief Engineers Association of Chicago which meets the second Wednesday of every month on the 23rd floor at 185 N. Wabash Ave.

About 130 prominent chief engineers of Chicago's office buildings, hospitals and industrial plants, advance operating engineers in the engineering profession, through association and general discussion of new developments that will increase economy and reliability of power-plant operation.

Business is transacted through a board of directors, of which all the officers are ex-officio members and to which one out of every five new members is elected. After the business session the engineers adjourn to a free dinner. Manufacturers and supply men are invited to this dinner, but are not permitted to become members.

After dinner a guest speaker discusses some vital engineering topic and then the meeting is opened for discussion.

Committees are being formed in the various branches of engineering. The Association is seeking the cooperation of manufacturers and utilities in order that more scientific and technical data can be brought to the attention of engineers interested in advancing their technical knowledge.

G.E. and Schenectady Celebrate Anniversary

To commemorate the establishment of the electrical industry in Schenectady, N. Y., by Thomas A. Edison, the local Chamber of Commerce sponsored a celebration there on June 12 and 13. Fifty years ago Edison took title to two abandoned shops of McQueen Locomotive Co., as a new location for the Edison Machine Works, thus laying the foundation for a local industry which developed into the present General Electric Co. One of the outstanding events of the two-day celebration was a formal dinner on Friday evening for more than 500 invited guests, at which the chief speakers were Owen D. Young, chairman of the G.E. Board of Directors; Dr. George R. Lunn, N. Y. State public service commisisoner; Charles A. Edison, son of the inventor, and W. S. Barstow, Edison pioneer and president of the Thomas Edison Foundation.

Nason—Heating Pioneer And Inventor

Forty years ago *Heating & Ventilation* published a biography which has just been brought to *Power's* attention. It will probably be news to most readers, as it was to the editors, that one Joseph Nason, born in Boston in 1815, was the founder of American steam-heating practice.

In 1827 Nason went to Lowell, Mass., where he got the essential machine-shop training that served him so well later. Like James Watt, he was a mechanic first, last and always. He visited England in 1838, met Angier Perkins, son of Jacob Perkins, America's famous steam inventor, and learned of Angier Perkins' system of hot-water heating.

In 1842 the firm of Walworth & Nason was founded to take orders for heating systems, and a series of remarkable inventions began. Up to that time pipe fittings had been hand forged from wrought iron. Nason developed a standard line of cast-iron fittings, practically interchangeable, later producing malleable fittings, as well. Angle valves were on the market, but no straight-run pipe stops except cocks. So Nason invented the globe valve, which by itself should entitle him to fame. Perhaps even more important was his invention of pipe threads tapered to insure tight joints.

At Burlington, Vt., in 1845, the firm completed the first exhaust-steam heating job in any American factory. Shortly thereafter, in 1846, Nason made the first American installation of indirect hot-air heating. This was at the Boston Customs House. It used indirect heating coils and a fan modeled after a steam-boat paddle wheel.

Nason moved to New York in 1852, set up a branch of his firm there and devised and introduced malleable-iron fittings. He invented numerous machines for the multiple machining and tapping of fittings at high speed. Before his death (1872, Montclair, N. J.), Joseph Nason had three more major inventions to his credit: the cast-iron radiator (also the name "radiator"), the steam trap and the balanced regulating valve.

It is interesting to note that the business founded by this steam and heating pioneer has recently been purchased by Detroit interests. The Nason Co., as it is now called, has its headquarters at 1050 Mount Elliott Ave., in that city.

New 5,000-Kw. "Top" For Mound St. Station

A NEW "top" for Mound St. Station of Laclede Power & Light Co., St. Louis, Mo., took load June 10. In the new building, which provides space for another boiler and turbine if needed, are two 13,500-sq.ft. (nominal) Springfield water-tube boilers generating steam at 450 lb. and 850 deg. and a 5,000-kw. Allis-Chalmers turbine exhausting to the old plant at 185 lb. and 485 deg. The boilers are fired with 950-B.t.u. natural gas through Coen burners which may be converted for oil firing in emergency in less than 5 min. Eventual use of pulverized bituminous coal is provided for should it be desired. The plant has Leeds & Northrup "Micromax" combustion control, Republic flowmeters, American (Consolidated Ashcroft Hancock) gages, Hall feedwater control, and three Worthington feed pumps, two motor driven and one turbine driven. Boiler breechings enter a single steel stack centered over them.

The Heine and Springfield boilers of the old plant will be used for standby only. The

old turbine equipment includes two 7,500-kw. G.E. turbines, one 5,000-kw. Westinghouse, and a 3,500-kw. G.E., all condensing units operating at 185 lb. and 485 deg. These will use steam exhausted from the new unit supplemented by necessary additional steam through a reducing valve.

Prague Orders Loeffler Boiler

A LOEFFLER boiler, to supply 150,000 lb. of steam per hr., at 1,950 lb. pressure and 950 deg. F., has been ordered for Holesovice municipal power and heating plant in the center of Prague, capital of Czechoslovakia.

The old part of the station (52,000 kw. operating at 300 lb.) will be maintained for peak-load operation only. The high-pressure section will have an initial capacity of 21,000 kw.

Holesovice is a combined heating, steam and condensing station, steam being used to heat houses and factories in Prague. Higher pressures will increase the attention devoted to heating applications.

Feed-water is partly condensate and partly chemically treated. The Loeffler steam-circulating pump will be driven by a back-pressure turbine whose exhaust will be used to heat feed-water.

The Loeffler boiler, built by the Vitkovice Mines, Steel and Ironworks Corp., Czechoslovakia, has two evaporator drums and is fired with chain-grate stokers and burns low-grade coal. Combustion air is preheated to 470 deg. F.

NEWS NOTES

IDAHO POWER CO., Boise, Idaho, won the 1935 annual award of the Charles A. Coffin Foundation established by the General Electric Co. in 1922. The award comprising the Charles A. Coffin gold medal, a certificate, and a check for $1,000 to be deposited in the treasury of the utility's employee welfare association, was for "its demonstrated ability to coordinate efficient and profitable utility operation with the activities of irrigators and government agencies in the power field."

GOVERNOR LEHMAN has approved Ross Bill sponsored by the Water Power & Control Commission, which provides a method to improve the channel, construct dikes or regulate the flow of a river for protection from damage by floods. Such work in general is to be done at the expense of the owners of the properties and the political subdivisions benefited.

1976th session of the Leipzig Trade Fair will be held from August 30 to September 3, inclusive, and from present indications will comprise 6,000 exhibits. This will make it the largest as well as the oldest industrial exchange in history.

ORGANIZATION of the Industrial Smoke Abatement Association of Hudson County, N. J., sponsored by Wm. G. Christy, smoke abatement engineer of the county, to cooperate with the Dept. of Smoke Regulation, was completed May 22. At the organization meeting, A. W. Atkins, superintendent of power, Standard Oil Co. of New Jersey, was elected president. Other officers are: G. H. Binder, vice-president, Woburn Degreasing Co., Harrison, first vice-president; W. L. E. Keuffel, secretary Keuffel & Esser Co., Hoboken, second vice-president; J. S. Hollowell, superintendent Natural Products Refinery Co., Jersey City, third vice-president, M. Edward Verdi, president, Verdi Bros. Cooperage Co., North Bergen, fourth vice-president, H. Yunker, chief engineer, Jersey City Printing Co., Jersey City, secretary; and John Gerhard, chief engineer, Swift & Co., Kearny, treasurer.

NATIONAL ASSN. OF POWER ENGINEERS will hold its convention in Chicago, August 30 to September 4.

AIR-CONDITIONING MANUFACTURERS' ASSOCIATION and REFRIGERATING MACHINERY MANUFACTURERS' ASSOCIATION adopted standard forms of warranties at their recent meeting in Hot Springs, Va.

APPROXIMATELY $3,000,000 in steel products and steel-making equipment will be exhibited at the annual exposition sponsored by Assn. of Iron and Steel Engineers at Convention Hall, Detroit, for four days beginning September 22, according to G. R. Carroll, president.

"ENGINEERS' DAY" at the Great Lakes Exposition is being planned by a committee representing the Cleveland Engineering Society, local sections of National Societies, and other technical and semi-technical organizations for July 11. The exposition marks the one-hundredth anniversary of the incorporation of the City of Cleveland.

RUSSIA'S development of heat and power stations during the first and second five-year plans is one of the most important achievements of the Soviet power industry, according to an article by N. N. Romanov, assistant chief of the planning dept. of Central Administration of the Power Industry, in the "Moscow Daily News" of June 1. The country now possesses several dozen power plants which exhaust into mains for heating the city. The Soviet Union now has the largest heat-supplying industry in Europe and is expected to overtake the U. S. soon.

POWER Show, Twelfth National Exposition of Power and Mechanical Engineering, to be held during the week of Nov. 30, 1936, is expected to be greater than the Eleventh Exposition. Two of three floors to be used at Grand Central Palace, where the Exposition will be held, are almost entirely filled with veteran exhibitors and many newcomers.

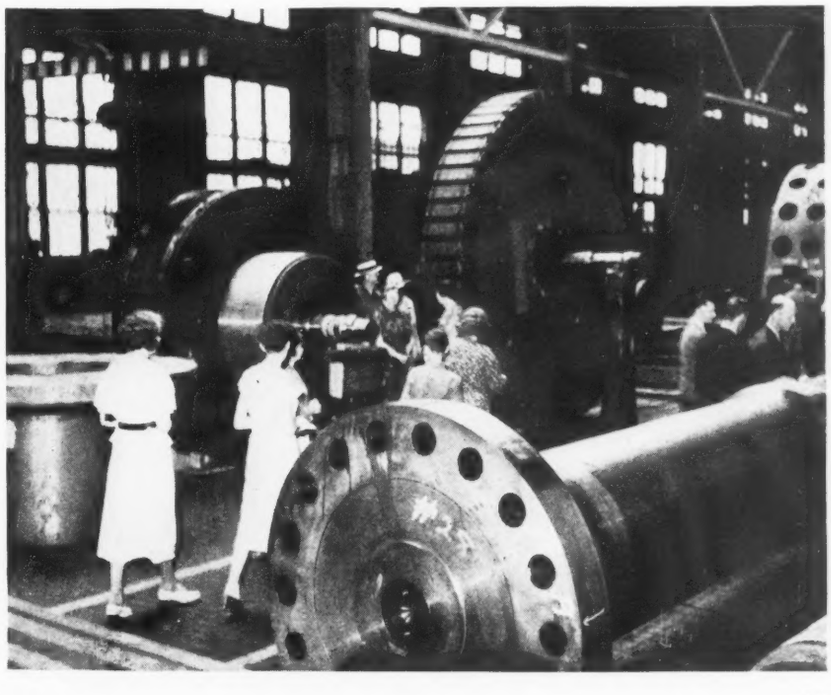
MARC G. BLUTH, executive secretary, Committee of Ten—Coal and Heating Industries, and secretary, Stoker Manufacturers Assn., spoke on the effects of increased installations of mechanical and automatic coal-burning equipment may have in helping to solve smoke abatement problems, at the annual convention of the Smoke Prevention Association, Atlanta, Ga., June 4, 1936.

AMERICAN Standards for Lightning Arresters (C62-1936), developed by the Sub-Committee on Lightning Arresters of the American Institute of Electrical Engineers' Technical Committee on Protective Devices, has been approved by both the A.I.E.E. and the A.S.A.

63,000,000 gal. of liquefied petroleum gases were used during 1935, according to Martin J. Conway, fuel engineer for Lukens Steel Co., in a paper presented before the N.A.P.E. in Philadelphia, April 10. On the Pacific Coast truck and trailer units are hauling propane and butane 300 miles for dis-

OPEN HOUSE AT G.E.

When Schenectady, N. Y., celebrated the fiftieth anniversary of the founding of the electrical industry there by Thomas A. Edison, General Electric Co., held open house. Here are some visitors in Building 16 where large motors and hydro-generators are made



tribution in the undiluted form, diluted with air or mixed with water gas. The gases are used to fire boilers, and although their flame temperatures are lower than acetylene, they find application in cutting steel, brazing brass and bronze, welding of aluminum and lead-burning. Increasing industrial applications are for heat-treating furnaces and internal combustion engines.

FOREIGN STRAWS

CANADIAN KODAK CO., LTD., Mt. Dennis, Ont., is receiving bids for extensions to its power plant.

SASKATCHEWAN SUPPLY & FUEL CO., Canada, recently installed two 150-hp. boilers and two Iron Fireman pneumatic spreader stokers in the plant of the Saskatoon Brewery in Saskatchewan. To keep the brewery in operation, a Canadian National Railways locomotive was rented to supply steam.

ONTARIO HYDRO-ELECTRIC COMMISSION, to eliminate necessity of importing Quebec power, is preparing plans to transform Gibson Lake on Niagara Escapement into storage basin and development of 250,000 hp. at Decen Falls.

GENERAL HOSPITAL, Vancouver, B. C., has applied for $100,000 to remodel its heating and electric plant. It is claimed the plant is not in condition to serve another year.

OBITUARIES

FERDINAND W. ROEBLING, JR., president of John A. Roebling's Sons Co., died May 29.

W. A. MORSE, 51, superintendent of Mound St. Station, Laclede Power & Light Co., St. Louis, Mo., for the past six years, died May 24. He had just been completing a new "top" for the station.

WILLIAM G. ELY, retired manager of the contract service dept. of General Electric Co., died in mid-June at Charleroi, Belgium.

GEORGE R. MURPHY, 61, formerly manager of the Pacific Coast district of the Electric Storage Battery Co., died May 14.

GEORGE F. POORE, 82, for many years stationary engineer at the Ipswich, Mass., pumping plant, died June 1.

PERSONALS

D. M. JOHNSON of B. C. Electric Railway Co. was elected chairman of Vancouver branch of A.I.E.E. at the annual dinner recently. Other officers elected are: vice-chairman, E. G. Callwick, professor of electrical engineering, U. of B. C.; secretary, J. H. Steede, B. C. Electric Railway Co.

SIDNEY E. PACKARD, engineer, Foster Machine Co., Westfield, Mass., was elected president of New England section of N.A.P.E. at annual meeting in Boston, June 12, succeeding William A. Fearney of Providence, R. I. Harry Schildige, engineer for Cheney Bros., South Manchester, Vt., was elected vice-president; Frank E. Guth, chief engineer, Hotel Touraine, Boston, was made secretary, and Walter H. Damon, retired superintendent of power, United Electric Light Co., re-elected treasurer. Over 1,000 engineers attended the convention, which included a display of 69 exhibitors of power-plant equipment at M.I.T.

DUDLEY P. CRAIG, associate professor of mechanical engineering at Purdue University, and a member of the staff since 1921, has tendered his resignation effective August 8, to accept a post as professor and head of the Mechanical Engineering Dept. of Colorado State College of Agriculture and Mechanic Arts at Fort Collins, Colo. Professor Craig has been in charge of heat engineering course at Purdue as well as co-author of a text book, "Steam Power and Internal Combustion Engines."

R. M. HANSON, Minneapolis, Minn. General Electric Co., was the winner of one of the James H. McGraw awards for his paper on "Circulation in Water-Tube Boilers." Mr. Hanson received his check for $250 (first prize) at the E.E.I. Convention in St. Louis, June 4.

H. C. MANN, senior materials engineer, U. S. Ordnance Dept., Watertown Arsenal, was awarded Charles B. Dudley Medal for 1936, at annual A.S.T.M. meeting in Atlantic City, July 1. Winning paper, presented at 1935 meeting, was "Relation Between Tension Static and Dynamic Tests."

JULIUS KAHN, president since his founding of Truscon Steel Corp., 33 years ago, has resigned to become vice-president in charge of product development of Republic Steel Corp., Cleveland, Ohio.

RAY C. GODDARD, vice-president Steel Engineering Products Corp., Combustioneer Division, Springfield, Ohio, was elected president of Stoker Manufacturers' Assn. at its 19th annual meeting held at White Sulphur Springs, W. Va., June 11 to 13. Louis Schwitzer, president, Schwitzer-Cummins Co., Indianapolis, was elected vice-president.

A. T. HOBBS, secretary of the Institution of Water Engineers and Institution of Highway Engineers, has been appointed to succeed Rear-Admiral J. HOPE HARRISON, R.N. (Retired), as joint honorary secretary of the Diesel Engine Users Association, 56, Victoria St., Westminster, London, S.W. 1.

L. W. GROTHAUS, recently elected vice-president of Allis-Chalmers Mfg. Co., Milwaukee, Wis., has been with the company 32 years, working in its Norwood shops, purchasing department, drafting room and engineering department. In 1917 he became a member of the staff of the War Industries Board. Continued promotions made him general representative of the company in 1931, and in 1933 assistant to the president.

J. F. G. MILLER, vice-president, B. F. Sturtevant Co., Hyde Park, Mass., was elected president and member of the board of directors of Air Conditioning Manufacturers Association at their recent meeting in Hot Springs.

R. G. ALLEN has been appointed sales manager for Walters Mfg. Co., St. Louis, Mo., at 51 East 42nd St., New York, N. Y. Mr. Allen has already opened offices in Connecticut, New Jersey and Pennsylvania.

MONTELLE C. SMITH, president of El Paso (Texas) Electric Co., and of the Mesilla Valley Electric Co., Las Cruces, N. M., has been elected executive vice-president of Virginia Electric & Power Co., Richmond, Va.

L. E. DUNKELBERGER, formerly chief engineer of the St. Louis plant of Kroger Baking Co., has become chief engineer of the Reynolds Wire Co. plant at Dixon, Ill. He is succeeded at Kroger by F. E. Tapy, with the company in Detroit for the past year. Mr. Tapy is a graduate of Rose Polytechnic Institute.

A. C. FIELDNER, chief engineer, Experiments Station Division, U. S. Bureau of Mines, Washington, D. C., was elected president of the A.S.T.M. at its annual meeting, June 30, at Atlantic City. T. G. Delbridge, manager of Research Development Dept., Atlantic Refining Co., Philadelphia, Pa., is vice-president.

J. A. JACOBS, chief engineer, Colgate-Palmolive-Peet Co., and president of the Professional Engineers' Club of Hudson County, N. J., was given a testimonial dinner by the organization June 22, at the Carteret Club in Jersey City. Guest speakers included S. Bayard Colgate, president of Colgate-Palmolive-Peet Co., Harry C. Beaver, president of Worthington Pump & Machinery Corp., and Frederick O. Runyon of the State Board of Professional Engineers and Land Surveyors.

DR. HARVEY NATHANIEL DAVIS, president of Stevens Institute of Technology and widely known authority in the field of steam table research, was tendered the degree of Doctor of Engineering by New York University at its recent commencement exercises.

M. W. SMITH (above) is the new manager of engineering for Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Mr. Smith has been with Westinghouse since 1915, when he graduated from Texas A. & M. College.

E. J. LEES, formerly of Lees-Bradner Co., has been appointed engineer in charge of engineering and research for National Tool Co., Cleveland, Ohio. Mr. Lees is the inventor and builder of many outstanding gear machines.

KARL E. SABOE, former district representative and one of the oldest employees, has been selected for the newly created position of industrial sales manager, Cleveland, for Iron Fireman Mfg. Co.

C. M. TATE, for past two years with Askania Regulator Co., has joined Hagan Corp., Pittsburgh, Pa.

BUSINESS NOTES

JENSEN-BYRD CO., Spokane, Wash., has been appointed distributor of Enduro Stainless Steel by Republic Steel Co., Cleveland, Ohio. Cameron and Barkley Co., of Florida, will distribute Republic tubular products.

CONSOLIDATED CHIMNEY CO. was incorporated recently by Robert O. Hudson formerly with Continental Chimney Co., Chicago, Ill. and Victor T. Holmsten, with offices at 140 S. Dearborn St., Chicago, Ill. Company will specialize in construction and maintenance of chimneys.

CHAS. TAYLOR SONS CO., Cincinnati, Ohio, has moved its eastern district sales office to the Hudson Terminal Bldg., 30 Church St., New York, N. Y.

CHICAGO PNEUMATIC TOOL CO., New York, N. Y., has opened a sales and service branch at 2415 Commerce St., Dallas, Tex., under D. G. Reeder, district manager.

CRANE-O'FALLON CO., with branches in Denver, Grand Junction, Pueblo, Colorado, Casper, Wyo, Albuquerque, New Mexico, and El Paso, Tex., has been appointed representative for American District Steam Co., North Tonawanda, N. Y.

INDEPENDENT AIR FILTER CO., INC. has opened an office at 55 West 42nd St., New York, N. Y. under Henry Gittelman.

CHAS. M. BAILEY CO., INC., 342 Towne Ave., Los Angeles, Calif., has been appointed representative for JAS. P. MARSH CORP.

THE DAMPNEY CO. OF AMERICA, has opened a branch office in 1323 Michigan Theater Bldg., 220 Bagley Ave., Detroit, Mich., under C. M. Boling, formerly resident engineer at Cleveland, Ohio.

MINNEAPOLIS - HONEYWELL REGULATOR CO. has enlarged its plant and main office at Minneapolis. For research facilities, as well as comfort, three complete air-conditioning installations have been made to provide for offices and engineering department on sixth floor, and a portion of fifth. Detroit branch office of company has moved to 415 Brainard Ave. Providence district office has moved to 397 Elmwood Ave. Two new district offices, in New Orleans, La., under Paul E. Seepe, and at Charlotte, N. C., under Karl Selden, have been established. European branch office has moved to Wydesteeg-4, Amsterdam, Holland, and has added Brown Instrument line.

CATERPILLAR TRACTOR CO. has elected A. T. Brown, former general auditor and assistant secretary to vice-president. G. D. Sherwin, vice-president, was named treasurer, succeeding Henry M. Hale, who has been appointed manager of the Eastern sales division. E. R. Galvin, former Eastern sales manager, has been made assistant general sales manager.

CRANE CO., La Crosse, Wis., has appointed Saltzer and Weinser, Inc., Brooklyn, N. Y., as agents.

NATIONAL BOILER IMPROVEMENT CO., INC., Washington, D. C., has opened an office at 140 Cedar St., New York, N. Y., under D. V. Egbert.

CORNING GLASS WORKS has completed arrangements whereby U. S. Gypsum Co. and Armstrong Cork Products Co. will act as sales agents for their fibrous glass products.

MINE AND SMELTER SUPPLY CO., Denver, Colo., Salt Lake City, Utah, and El Paso, Tex., has been appointed sales agent for Robins Conveying Belt Co.

JENSEN-BYRD CO., Spokane, Wash., and CAMERON AND BARKLEY CO., Fla., have been appointed sales agents for Republic Steel Corp., Cleveland, Ohio.

TOMLINSON STEAM SPECIALTY CO., 1603 St. Clair Ave., Cleveland, Ohio, has been appointed sales representative for Edward Valve & Mfg. Co., Inc., East Chicago, Ind.

WESTCO PUMP CORP., Davenport, Iowa, has merged with Micro Corp. of Bettendorf, Iowa. The new concern will be known as Micro-Westco, Inc., and will be in Bettendorf Office Bldg., Bettendorf, Iowa.

JULIEN P. FRIEZ & SONS, INC., Division of Bendix Aviation Corp., Baltimore, Md., celebrated its 60th year on June 1.

Westinghouse Launches Sealed Refrigeration

To mark the commercial development of hermetically-sealed refrigeration in units of industrial size, Westinghouse Electric & Manufacturing Co. held an all-day session last month at its East Springfield, Mass., factory. Nearly forty editors of business and technical journals made the trip to Springfield to study the new units, for the manufacture of which approximately one-half million dollars has been spent in developing designs and equipping the factory.

Fundamentally, what has been done is to extend to industrial sizes the principle of hermetically-sealed refrigeration used for some years in household-size refrigerators and more recently in the so-called "commercial sizes." The units, however, are intended primarily for use in air-conditioning.

To eliminate all stuffing boxes, the new units seal motors as large as 25-hp. within a housing cast integral with the compressor crankcase. The rotor of the motor is hung (without coupling or outboard bearing) on a stub extension of the crankshaft.

Since no alignment of the motor is necessary, the condenser tank serves also as a bedplate. All refrigerant openings and passageways are cast in the crankcase, to eliminate such piping. Other special features include water-cooled motor, and a special flange plate to shift condenser coils from series connection for city water to parallel connection for cooling towers.

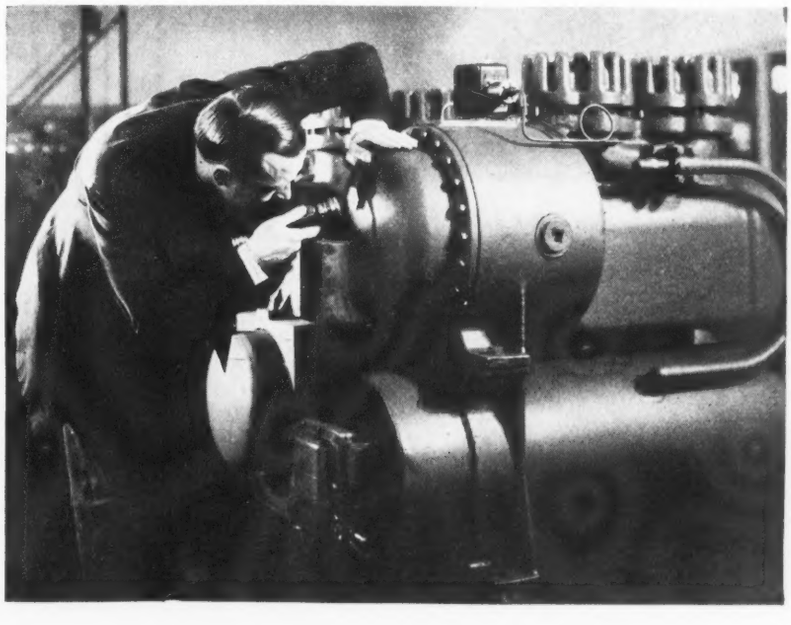
Because of the water cooling, and complete sealing, it is claimed that the new Westinghouse unit can be located almost anywhere, for example under stairways, or even outdoors exposed to the weather.

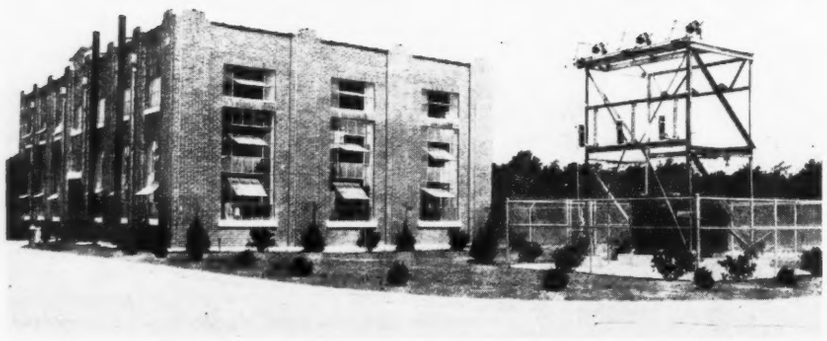
The units use Freon exclusively as refrigerant. The four cylinder sealless design weighs 1,600 lb., runs at 1,160 r.p.m., and is tested for 156,000 B.t.u.-per-hr. capacity. Driving motor is 15 hp.

While making air conditioning evaporators, as well as the refrigerating unit itself, Westinghouse will leave the design and installation of complete air-conditioning systems in the hands of local consulting engineers and contractors.

HERMETICALLY SEALED CONDENSING UNIT

Looking through inspection glass to check rotation of motor in one of Westinghouse's new industrial-size, sealed refrigerating units





MUNICIPAL POWER FROM SEWAGE

Durham, N. C., supplements its hydro-electric plant and utility supply with power from its new sewage plant. A $760,000 P.W.A. grant facilitated construction of the plant and purchase of two 150-hp., 4-cyl., Cooper-Bessemer gas engine direct-connected to 100-kw. G.E. generators. Gas from three sewage digestors is stored in a single-lift, 50,000-cu.ft. gas-holder

STRAWS

Pointing the way business winds blow

U. S. BUREAU OF PRISONS, Pennsylvania Ave. and Ninth St. N.W., Washington, D. C., will build steam power house for central heating at Federal prison at San Pedro, Los Angeles, Calif. Will cost about $600,000.

DEPT. OF LIGHT AND POWER, City Hall, Cleveland, Ohio, plans improvements in municipal power station on East 53d St., with installation of automatic stokers and other equipment.

BOARD OF WINNEBAGO COUNTY COMMISSIONERS, Oshkosh, Wis., plans boiler plant in court house and jail for steamheating. Granger & Bollenbacher, 333 North Michigan Ave., Chicago, Ill., architects.

TWENTIETH CENTURY-FOX film studio, 10260 Orton Ave., West Los Angeles, Calif., plans one-story power house at studio to cost about $50,000. J. A. Barlow, company engineer.

WAPAKONETA, OHIO, will call for bids for extensions in municipal power plant. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

KNIFE RIVER MINING CO., Bismarck, N. D., plans boiler plant at coal-mining properties at Beulah, N. D., in connection with rebuilding of tipple destroyed by fire. Will cost close to $85,000. M. C. Blackstun, general manager.

STATE BUILDING COMMISSION, Jefferson City, Mo., plans cold storage and refrigerating plant at state penitentiary. Cost about $75,000.

WAYNE PUMP CO., Fort Wayne, Ind., plans boiler plant at pump-manufacturing works to include two 300-hp. boilers, stokers and auxiliary equipment. New coal bunkers will be built.

SPRING VALLEY, MINN., has contracted Fairbanks, Morse & Co., Chicago, for diesel for municipal power plant, to Donovan Construction Co., 1725 Carroll Ave., St. Paul, Minn., for distribution system. G. M. Orr & Co., Baker Bldg., Minneapolis, Minn., engineers.

SABINA, OHIO, has bond issue of $34,000 for extensions in municipal electric plant.

REILLY TAR & CHEMICAL CO., Merchants Bank Bldg., Indianapolis, Ind., plans power house at proposed coal tar products mfg. plant in Cuyahoga Valley, near Cleveland, Ohio. Will cost about $200,000.

MINERVA, OHIO, has identical bids for turbo-generating equipment for municipal power plant from General Electric Co., Westinghouse Electric & Mfg. Co., and Allis-Chalmers Mfg. Co., at $43,031, and will make award at early date. Bids have been asked also for condenser unit and accessories, superheater and other equipment. $76,000 arranged. H. Ralph Hadlow, 5005 Euclid Ave., Cleveland, Ohio, consulting engineer.

PET MILK CO., Arcade Bldg., St. Louis, Mo., plans steam plant at prepared milk mfg. plant at Coldwater, Ohio, to cost about $250,000. Helfensteller, Hirsch & Watson, Chemical Bldg., St. Louis, architects.

FARIBAULT (Minn.) CANNING CO. plans high-pressure boiler plant. Bids will be asked in fall. Ralph W. Richardson, New York Bldg., St. Paul, Minn., consulting engineer.

WILLIAM GORDON, INC., 450 Palisade Ave., West New York, N. J., plans boiler plant at gin distillery at Des Moines, Iowa, to cost about $100,000. William S. Gordon, president of newly-formed operating company.

U. S. ENGINEER OFFICE, Clock Tower Bldg., Rock Island, Ill., will receive bids until July 21 for Dam No. 21, Mississippi River, near Quincy, Ill., with mechanical and electrical equipment.

HUMBLE PIPE LINE CO., Humble Bldg., Houston, Tex., interest of Humble Oil & Refining Co., has surveys for welded-steel pipeline from Mexia, Tex., to oil field at Talco, Tex., about 140 miles, for crude oil transmission. Will cost about $5,000,000. Also planning 20-mile welded-steel pipeline for similar service from O'Connor oil field, Refugio County, Tex., to Heyser, Calhoun County, Tex., to cost close to $200,000.

COLUMBIA, MO., takes bids soon for extensions in municipal electric plant, including 5,000-kva., turbo-generator, 750-hp. boiler with accessories, condenser and auxiliary equipment. Cost about $280,000. Financing arranged. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

BEREA, OHIO, has authorized surveys for extensions in municipal power plant. William C. Kammerer & Associates, 823 Prospect Ave., Cleveland, Ohio, consulting engineers.

LORD CRAVEN HOTEL CORP., New Bern, N. C., Raymond Fuson, New Bern, president and architect, plans boiler plant in nine-story hotel for which bids will be asked soon on general contract. Refrigerating and cold storage plant will be installed. Will cost about $650,000. R. N. Scott, secretary and treasurer.

CLYDE, OHIO, has engaged Froehlich & Emery Engrg. Co., Second National Bank Bldg., Toledo, Ohio, consulting engineer, to plan extensions in municipal electric plant, with installation of turbo-generator and other equipment.

TRICO CO-OPERATIVE ELECTRICAL ASSN., Floodwood, Minn., L. E. Harris, president, plans diesel-electric plant for rural electrification. Financing will be through Federal aid.

ROSEWOOD STATE TRAINING SCHOOL, Owings Mills, Md., has awarded general contract to Cogswell Construction Co., 406 Park Ave., Baltimore, Md., for addition to power house. Cost about $75,000. Henry P. Hopkins, 10 East Mulberry St., Baltimore, architect.

UNITED ILLUMINATING CO., New Haven, Conn., has let general contract to Mott-Mohr Construction Co., Inc., 440 Elm St., New Haven, for two buildings at Steel Point plant, Bridgeport, Conn. Cost over $100,000. Westcott & Mapes, Inc., New Haven, architect and engineer.

HOME OIL & REFINING CO., Great Falls, Mont., plans 6-in. welded-steel pipeline from oil field at Cut Bank, Mont., to Great Falls, by way of Shelby and Conrad, Mont., about 100 miles. Also steel pipeline gathering system, about 20 miles. Cost about $675,000, with pumping stations.

HEYWOOD-WAKEFIELD CO., Gardner, Mass., soon begins construction of steam plant, 50x70 ft., at furniture factory. F. J. Sill, East Main St., Westboro, Mass., architect.

HOMESTAKE MINING CO., Lead, S. D., has contracted Nordberg Co., Milwaukee, Wis., for two 5,000-cu.ft. air compressors for gold-mining plant to cost about $150,000, installed.

FAIRFIELD DISTILLERY CO., INC., 234 East Main St., Louisville, Ky., plans power house at distilling plant at Bardstown, Ky., to cost about $160,000. Walter C. Wagner, Breslin Bldg., Louisville, architect.

UNIVERSITY OF NEW MEXICO, Albuquerque, has contracted Thomas Bates & Co., 2511 Tenth St., Denver, Colo., for steam

plant and central heating system for $146,402. John G. Meem, Santa Fe, N. M., architect.

CLAREMORE, OKLA., plans extensions in municipal electric plant, including diesel and auxiliary equipment. Cost about $60,000.

WHITE EAGLE OIL CORP., Federal Reserve Bank Bldg., Kansas City, Mo., plans 6-in. welded-steel pipeline from refining plant at Augusta, Kan., to Kansas City, Kan., by way of Topeka, Kan., about 175 miles, for gasoline transmission. Cost about $5,000,000, including pumping stations. Company affiliated with Socony-Vacuum Oil Co., Inc., 26 Broadway, New York.

STATE BOARD OF ADMINISTRATION, Capitol Bldg., Bismarck, N. D., has rejected bids for addition to power plant at State Normal School, Dickinson, N. D. New bids will be asked. William F. Kurke, 1117 Thirteenth Ave. N., Fargo, N. D., architect.

BOARD OF EDGECOMB COUNTY COMMISSIONERS, Tarboro, N. C., plans boiler plant for central heating at local hospital and county home. Entire project will cost about $100,000. Eric C. Flanagan, Henderson, N. C., architect.

PAINESVILLE, OHIO, plans extensions in municipal electric plant, with 550-hp. boiler and accessories, automatic stoker, etc. Cost about $100,000. Consulting engineer will be selected. C. S. Fullerton, city manager.

PAN AMERICAN REFINING CO., Texas City, Texas, has ordered a second spray-type cooling tower, 1,000-ft. long by 20-ft. wide by 54-ft. high, from Foster Wheeler Corp., 165 Broadway, New York. Both towers are built of California redwood and are exactly alike, but the second will handle more g.p.m., due to a reduction in cooling range. It will cool 41,000 g.p.m. from 111.7 to 90 deg. F. at 78-deg. wet bulb with a 3-mile wind at an angle of 45 deg.

OKLAHOMA CITY, OKLA., has estimates by Thomas G. Banks, city water engineer, for extensions in municipal water system, totaling $1,500,000. Will include enlargement in filtration plant, new pumping stations, water towers, main and distributing pipe lines, and other equipment.

HOLTON, KANS., has purchased a 225-hp. at 300 r.p.m., 4-cycle, 3-cylinder, 13¾x18-in. mechanical injection diesel from Fulton Iron Works. It will be installed early in August to take load about Aug. 15.

BANTAM BALL BEARINGS CO. is adding new machinery and building an addition to its plant at South Bend, Ind., as part of a $250,000 expansion program.

WARFIELD NATURAL GAS CO., Louisa, Ky., has surveys under way for welded-steel pipeline, 8 and 10-in., from gas field in Martin County, Ky., to Boldman, Pike County, Ky., about 20 miles, where connection will be made with booster station for natural gas transmission. Cost $100,000.

CHARLESTON, S. C., plans installation of pumping machinery and accessory equipment, 200,000-gal. steel storage tank and other equipment for extensions and improvements in water system, developing source on Edisto River. $1,000,000 being arranged for project, including water tunnel. James E. Gibson, water engineer for Charleston Public Works Commission.

WILLIAMSON-DICKEY MFG. CO., 509 West Rio Grande, Fort Worth, Tex., manufacturers of work clothes, is installing a 200-hp. Bruce-Macbeth gas engine to replace one of its two older 100-hp. units.

TUPELO, MISS., will rebuild municipal electric plant damaged recently by storm. $30,000 authorized for work.

KROGER BAKING CO., St. Louis, Mo., will soon install four 1,000-sq.ft. gas-fired boilers and auxiliaries at its "Piggly-Wiggly" baking plant. Steam is to be used for process and heating. A 90-ton brine refrigerating plant will also be installed to cool dough in process.

LANSING, MICH., plans call for bids during summer for addition to municipal electric plant, and improvements in present station. Generator, boilers and auxiliary equipment will be installed. Cost over $1,000,000. City engrg. dept., in charge.

ASHLEY Station of Union Electric Light & Power Co., St. Louis, Mo., is again being put into service because of low water at the Bagnell Dam of the Osage River.

FORD MOTOR CO., Dearborn, Mich., plans steam plant for lumber mill at L'Anse, Mich., on Plumbago Creek. Will cost close to $100,000.

PUBLIC UTILITIES COMMISSION. Water Dept., San Francisco, Calif., plans water supply for San Francisco Bay Exposition on Yerba Buena Shoals, with capacity of 2,500,000 gals. per day, to include new pumping station on Embarcadero, connecting with 10 and 12-in. pipe line leading to a reservoir on Yerba Buena Island, with storage capacity of 1,400,000 gals. Entire project will cost over $500,000. N. A. Eckart is chief engineer.

KREY PACKING CO., 2100 Bremen Ave., St. Louis, Mo., has just completed installation of two 4,300-sq.ft., 4-drum, bent-tube Erie City boilers generating steam at 300 lb. and 300% of rating. Steam is to be used in process and also to drive a 250-kw. Skinner Unaflow engine from the old plant. A new building and a 175-ft. brick stack were provided for the new units, which are expected to take load about July 1. Auxiliaries include Smoot control, Copes regulators, Coppus deaerating heaters, Jeffrey coal-handling equipment, Laclede chain-grate stokers. Fuel is Illinois bituminous screenings (1½ in.). Several pumps, etc., will be installed later.

DAIN MFG. CO., Ottumwa, Iowa, plans addition to boiler house at agricultural equipment mfg. plant, including installation of new boiler, stoker and auxiliaries. Coal storage plant will be enlarged and mechanical-handling facilities installed.

EVERETT, WASH., called special election to approve $1,000,000 extensions in water system to serve mill of Soundview Pulp Co., on basis of 12,000,000 gal. per day. Includes pipeline, pumping machinery and auxiliary equipment. S. E. Paine, city engineer and water superintendent.

BOULDER DAM HOTEL CORP., care of Harry J. Wiesler, Bank of America Bldg., San Diego, Calif., plans steam plant for central heating and other service at proposed hotel near Las Vegas, Nev. Cold storage and refrigerating plant will be installed, as well as large swimming pool, pumping plant and other facilities. Estimated to cost over $2,000,000.

NATIONAL DRY ICE CORP., Niland, Calif., plans welded-steel pipeline from Calexico, Calif., for natural gas to dry-ice mfg. plant. Application made for franchise. Cost over $50,000. W. E. Morse, president.

ANAHEIM (Calif.) CITRUS FRUIT ASSN. has contracted Gay Engr. Corp., 2650 Santa Fe Ave., Los Angeles, Calif., for one-story precooling plant, 60x110 ft. Cost $60,000 with equipment.

ARTHUR BONE, INC., Los Angeles, Calif., knitting plant, has installed six 9-kw. electric unit heaters made by Ilg Mfg. Co. Units are suspended 7 ft. above the floor on each side of room for rayon knitting process.

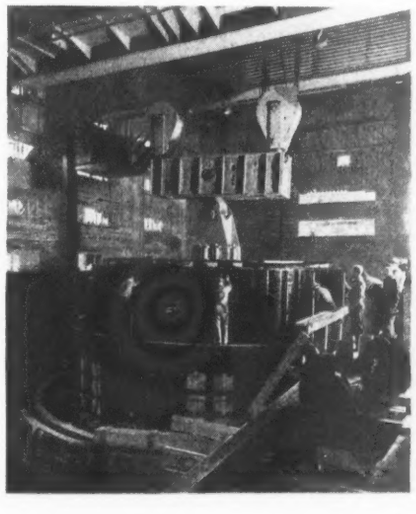
SALEM, ORE., has bonds for $1,000,000, for extensions in municipal water system, including 30- and 36-in. steel pipeline from North Santiam River to city about 17 miles, 10,000,000-gal. filtration plant, reservoir and pumping stations. To ask bids soon. Stevens & Koon, Spalding Bldg., Portland, Ore., consulting engineers. Cuyler Van Patten, city manager.

STATE CAPITOL CONSTRUCTION COMMISSION, Salem, Ore., T. Harry Banfield, commissioner in charge, plans boiler plant in capitol bldg. Goodhugh Livingston, Trowbridge & Livingston, 101 Park Ave., New York, architects, will prepare plans. Air-conditioning will be installed with other utilities. Structure will cost $2,000,000, exclusive of fixtures.

BENTON COUNTY PUBLIC UTILITY DIST., Prosser, Wash., is negotiating purchase of Pacific Power & Light Co. power plant to operate it as cooperatively-owned property. Extensions will be made, including 1,000-kw. generator and auxiliary equipment. Cost close to $50,000. John Whitehead, manager.

500,000-LB. LOAD AT NORRIS DAM

Lowering the rotor of a 56,000-kva. generator into its stator by a 250-ton crane at Norris Dam on the Clinch River, a tributary of the Tennessee. The rotor, which is the heaviest part of each of two units, weighs 500,000 lb. exclusive of the shaft. A complete generator, without the turbine, weighs 1,100,000 lb.



TRADITION...

Ivied walls, hallowed spots, houses where Washington slept, things that "came over in the *Mayflower*"—all these are parts of the American tradition. They are only the beginnings of the list.

Traditions have their place—an important one—but they should be kept in it. When they interfere with everything that is practical, then they go too far. I remember the roar of damning laughter I heard several years ago when several of us were discussing the plant engineer down in Arizona who wears just shorts and shoes in summer. His engine room reaches 115 deg., so he changed the traditional garb for comfort. He even goes so far as to have two pairs of shoes, one pair on and one in the icebox.

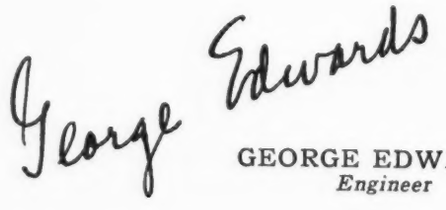
Unconventional? Sure! He wanted comfort, and got it. Why must he wear overalls and jacket, or a business suit, just because engineers always wear them? Tradition in his case was interfering with efficiency.

Tradition-mindedness isn't limited to working clothes either. You have buttons on your coat sleeve. Why? The story is that the nobles four or five hundred years ago wiped their noses on their sleeves, so tailors put buttons on to discourage the practice. And why do women walk inside when escorted? We say because tradition puts man on the outside to protect her. Actually, oldtime streets were narrow, and householders threw all their rubbish out of the front door. Man walked in the center of the roadway, woman walked on the side, so that anything pitched out hit her and not him.

Good old tradition—suggesting that we do things the time-honored way, because everybody else does it, because it has always been done that way.

You've heard of Newcomen's, Smeaton's and Watt's fight to establish the steam engine. Contrary to tradition, said the oldsters. Yet Watt called Trevithick a murderer because he suggested 40-lb. steam pressures. When Porter brought high-speed engines to America, he was laughed to scorn. The same thing happened in the early days of the turbine, the diesel, automatic control, welding. Automatic feedwater control is still damned because it "makes the water tender lazy." Twice the necessary capacity is installed in some plants because old equipment used to break down and leave the plant without power—in fact many a sensible plant has been shut down because it couldn't show a profit based on all the excess capacity installed. Tradition dictates a bright and shining engine room, but the boiler-room is something else again. Tradition dictates that it is supposed to be dirty.

The only antidote for such backward thinking is an inquiring mind, reasoning out the why of everything. It might pay us, large or small, to figure out how many of our operating methods, how much of our set-up, what parts of our plant are just costly tradition. Less tradition in our thinking might encourage the Boss to have less in his—remember history is made by tradition-breakers.



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